["TEXTS AND NOTES ON MEDIA TEMPORE(E)ALITIES"]

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I "MEDIA TEMPOR(E)ALITIES" (nearly edited):

TEMPORALIZING THE PRESENT, RE-PRESENCING THE PAST. Towards a media-epistemology of technologically induced temporal affects

Archiving the present & co-presence of the past: A technological Moebius loop

Electronic transduction, the conversion of signals into information units (bits), interactive human-computer interfaces, the speed of micro-processes, recursive algorithms and feedback loops all result in new ways of negotiating "the present".

Time-critical action in electronic and digital technologies develops into an epistemology which radically challenges traditional "grand" temporal horizon spanning between a heavy "historical" past and an emphatic future, with a

shifting emphasis on actually nonlinear, algo"rhythmic"[1], con-temporary events.

Such augmentation of the present happens in the tight coupling of human time with machine time, resulting in resonant atunement (analog) and high frequency pulsation (digital). Analytical aesthetics deals with such affective temporalities.[2] But different from the phenomenological or neuroscientific focus on the human time-window of the present moment (roughly three seconds), media-archaeological analysis concentrates on the techno-mathematical temporal condition of signal processing itself. "Media archaeologists [...] describe the non-discursive practices of the techno-cultural archive. Media phenomenologists [...] analyze how phenomena in various media appear to the human cognitive apparatus, that is, to the mind and senses."[3]

While the human sense of "the present" is challenged by the immediacy of analog signal transmission and the delays of digital data processing, a different (non-)sense of time unfolds within technologies themselves. At that moment, human-related phenomenological analysis clashes with the media-archaeological close reading of the technological event, in an impossible effort to let the *temporeal* articulate itself.

The media-epistemology of technologically induced temporal affects ties together a two-fold analysis of the techno-affective time field: a) temporalizing and archiving the present (technically corresponding with analog delays and digital intermediary storage) - not to be confused with "archiving presence"[4], b) re-presencing the archive in shock-like, traumatic manners since phonographic recording.

The current transformation of "analog" media recording into the digital one is dramatic for memory culture. In the transformation from analog to digital transmission media, the act of archiving presence takes place. The digital present condenses into an archive in front of our very eyes.

Whereas analog broadcasting (radio, television) has been connecting the viewer to the event in front on the camera in temporal indexicality ("live" transmission), digital signal transmission is "archival" per definition: it takes intermediary computation ("real time"). Digital media culture is an archival structure - though a micro-archival one, the "algorithmic archive".

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1 See Shintaro Miyazaki, Algorhythmics. Understanding micro-temporality in computational cultures, *online* in: Computational Culture, Issue 2 / 2012; http://computationalculture.net
2 See Eleni Ikoniadou, The Rhythmic Event, Cambridge, Mass. / London (M.I.T. Press) 2014
3 Kjetil Jakobsen, Anarchival Society, in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154, section 6
4 See Hans Ulrich Gumbrecht, Production of Presence. What meaning Cannot Convey, Stanford, Calif. (Stanfort UP) 2004

The most radical form of "archiving presence" is the encapsulation of intrusive affects; according to Mardi J. Horowitz "a traumatic experience remains in a kind of memory storage". There is a link between the "presence affect" and storage theory. "One of the major features of trauma is its inherent latency of belatedness — the inability of the trauma victim to grasp and assimilate the traumatic existence in real time"[5] - just like the "latent" electrostatic image in Xerox copying machines, and the phenomenon of magnetic remanence. Latency, here, correlates with the neurological notion of "implicit memory" where contents are not available to consciousness.

In technical terms of digital calculation, the delay is inherent in the notion of "real (signal processing) time" already - different from the time-indexical "live" signal transmission. Trauma studies often lack a close reading of the technologies implied.[6] For an analysis of both modes of generating presence, such studies require to be correlated with the media-archaeological approach which identifies technology-induced traumatic tempor(e)alities respectively memories, in order to work out their affinities and differences to the familiar traumata caused by historic war, genocide or terrorism experience.

Disruptions of the present generated from within (and preserved by) technological media

G. W. F. Hegel once defined the tone as transitive being. Such ephemeral cultural articulations have been subject of philosophy for long time. Media archaeology (in terms of technological measuring of a sound as event) allows to ground such insight in the signal event itself. With the emergence of signal recording media like photography, phonograph, cinematography, magnetic tape and finally digital recording, however, technical media allow for capturing the present, resulting in an unforeseen disposal of tempor(e)alities. Such media-induced time shiftings and time axis manipulations - while apparently smoothly integrated into everyday cultural practices - still are an affective shock which the cultural unconscious has not yet fully digested.

"Archiving" the present is understood here not in the passive sense of accumulating signals or data in a structured way, but rather in Foucauldean and Derridean terms as a generating principle (*archive / arché*). Different from what Gumbrecht more recently called "production of presence"[7], the focus is on technological abilities to generate fuzzy *presents*. The terminologial effort of *smeared present* is deliberately close to the concept of *fuzzy logic* in computing science.

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5 Mati Shemoelof, RealityTrauma Alienated Past and Alienated Present: On the Engagement with Nightmarish Light, in: Avi Ganor, RealityTrauma, exhibition catalogue Tel Aviv Museum of Modern Art, 2011, 175-203 (203); reference kindly provided by Marcus Bastos (October 2016)
6See `Cathy Caruth, Unclaimed Experience. Trauma, narrative and History, Baltimore (Johns Hopkins UP) 1996`
7 See Hans Ulrich Gumbrecht, Production of Presence. What meaning Cannot Convey, Stanford, Calif. (Stanfort UP) 2004

Psychological presence effects for players of computer games emerge in moments of suspense of self-consciousness. The expression "for the present" (which equals *einstweilig* in German) reminds of Husserl's conceptual protention[8], while retention is "the process by which an awareness of 'now' is synthesized with previous instants held momentarily in consciousness to yield a sense of temporal unity and flow."[9] The sonic equivalent to this state of extended consciousness of the present is acoustic reverberation; any damped oscillation slowly fades away. It is exactly at that point that vacuum-tube based electronic developed the circuit which produces undamped, sustained oscillations as basis for, e. g., radio transmission or synthesizer tones. While the very retentive experience of presence in phenomenology creates the impression of a "living" present exactly because it tends to death (a Heideggerean "being-to-death"), the electronic loudspeaker-based acoustic presence is a timeless present.

The administrative *arché* and the traditional "archive" (the symbolic order as operated in the textual record) has been technologically challenged by non-alphabetical media recordings (starting with photography and the phonograph), allowing for not simply "archiving" presence in the symbolical mode, but to re-store presence to the affective, signal-based level of perception. The tempor(e)alty of affect is now being matched by micro-technical moments of intermediary storage.[10]

Due to the ephemeral nature of its object, the study of presence has become inseparable from the study of its archiving media. Recording media have molded the perception of presence; analogue signal-recording media and recently signal-processing (DSP chip based) media have enhanced the power of generating the affective experience of presence. Recording technology made it possible for the first time to store, repeat, and manipulate presence. An escaping moment (the physical signal) now became an object of communication analysis that could be replicated and analyzed. The different ways of storage result in different ways of re-storing presence both in individual and collective "memory". In digitaql media, the symbolic regime and signal recording converge: the alphanumeric code, algorithmically processed in hardware-based signal processing.

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8 See Don Ihde, Listening and Voice. Phenomenologies of Sound [*1976], Albany, NY (State University of New York) 2007, chap. 7 "Timeful Sound", esp. 89 ff. (referring to an earlier translation of Edmund Husserl's *The Phenomenology of Internal Time Consciousness* by James Churchill, Bloomington, Ind. (Indiana University Press) 1964

9 Joseph Clarke, For a History of Liveness, in the architectural journal: log, vol. 33 (2015, forthcoming), 25-37 (35), referring to: Edmund Husserl, Phenomenology of Internal Time-Consciousness [GO *1928], Bloomington (Indiana University Press) 1964, 52–53, §12

10 See Peter Hartocollis, Time and timelessness, or The Varieties of Temporal Experience (A Psychoanalytic Inquiry), New York (International Universities Press) 1983, chap. V "Time as a Dimension of Affects", 59-78

Different from alphabetically coded memory of the past, signal storage media can immediately re-create the affect of presence in human temporal sensation. What is cognitively know as belonging to the past (the familiar "historical" record) is phenomenologically perceived as affect of presence, resulting in a cognitive/affective gap which has not yet been reconciliated.

While recent research has discovered that the specific phonetic alphabet which is still in current use today has been invented to record, store and transmit the musicality of Homer's oral poetry, a different kind of alphabet - the digital code - nowadays dominates most processing of cultural communication. The conversion of analogue to digital media archives is not just another mode of cultural memory but a dramatic transformation of its essence. Algorithmic re-presencing needs to be thoroughly reflected by both media and cultural theory.

There are chrono-traumatic irritations of the sense of the present caused by signal recording and data processing technologies. The symbolical or technical inscription of traumatic experience is not only bound to specific historical situations, but rather much deeper rooted within the techno-epistemology of media themselves. From the phenomenological perspective, photography, phonography, cinematography, videography, the magnetic tape, and finally digital recording affect the human sense of time. Although apparently accommodated in every day consumption, this intrusion of the technically recorded past into the present has not yet been cognitively digested and continues to irritate the "cultural unconscious" - an explicit analogy to Benjamin's neologism of an "optical unconscious" which was inspired by Sigmund Freud's psychoanalysis, describing temporal evidence which is not accessible to human senses immediately but with the camera only - in slow motion and fast forward display.

Media-induced irritations of the sense of the present happen in irruptive ways; such incisions of time are traumatic tempo*realities* - pluralizing the tightly coupled time triad of past-present-future into a plurality of micro-temporal figures of delay, anticipation and intra-temporal (time-critical) moments. These temporealities share central features with what in academic memory studies has become known as the unhistoricizable of traumatic remembrance. Next to "the distinctive role of media in mediating collective trauma"[11], there is a traumatic irritation both of presence and the present induced by media technologies themselves. Psychological symptoms like being "out of sync" indicate a micro-temporal irritation; the Lacanean "real" invades the symbolic order as tempo*real* (German *Zeitreal*).

The tempor(e)al in the cinematographic apparatus

Any cinematographic projection derives from a storage medium (phonotgraphic image series on celluloid). But the professional shooting of a cinematographic sequence is a form of repetitive presence itself: camera shots as intervals which mostly require repetitive shooting ("takes"). Still every "take" - even for

11 Amit Pinchevski and Tamar Liebes, Severed Voices: Radio and the Mediation of Trauma in the Eichmann Trial , in: Public Culture 22:2 (2010), 265-291 (267)

the most narrative "fiction film" - is a time-authentic recording, since it is unique in its individual nuances.

Can cinematograpic experience be "historicized" and thus be integrated into historical discourse, or does the shock of its oxymoronic power of "re-presencing" (Vivian Sobchack) the dead, the passed, remain a traumatic momentum, that is: not entering conscious symbolical mastering? Has the shock of the first "movie" screening in Paris 1895 been digested in the cultural unconscious at all, or does it insist as a sub-cultural irritation? "As soon as one is aware that a film can be viewed again - that this experience of presence can be repeated - it becomes a record [...]."[12] But "[i]t would be more accurate to say that photography and the cinema produce the sense of a present moment laden with historicity at the same time that they encourage a belief in our access to pure presence, instantaneity."[13]

Auratic presence and the aesthetics of "live"

Theodor W. Adorno remembers an acoustic scenario where he once was able to compare his actual listening to a nightingale through the open window with the radio transmission of the same bird's song: "[...] the author [...] managed to listen to it over the radio when the windows were open. The result was that we were able to hear the radio nightingale a bit earlier than we could hear the real voice because sound takes longer to reach the ear ordinarily through space than by electrical waves. The real nightingale sounded like an echo of the broadcast one. Thus the 'radio voice' creates a strong feeling of immediate presence. It may make the radio event appear even more present than the live event"[14]

Where does "live" stop and "delayspace"[15] start?

The destruction of the "aura" of a work of art by technical reproduction (Walter Benjamin) is foremost an instrusion into its temporal structure; "aura" is bound to its specific (almost Bergsonean) time figure, between the temporal now ("the present") and auratic appearance ("presence" and "re-presencing").

Technologies of communication are analogous to "those phenomena and conditions that contribute to the production of meaning, without being meanings themselves"[16] - the Kantean *a priori* transformed into a processual element, plausible for the technological production of presence.

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12 Mary Ann Doane, The Emergence of Cinematic Time. Modernity, Contingency, the Archive, Cambridge, Mass. (Harvard Univ. Press) 2002, 104
13 Doane 2002: 104
14 Theodor W. Adorno, Current of Music. Elements of a Radio Theory [1940], ed. Robert Hullot-Kentor, Frankfurt/M. (Suhrkamp) 2006, chap. V "Time - Radio and Phonograph", 120-128 (120)
15 A term coined by Marcus Bastos for his media theatrical performance 2014; http://www.eventualidades.net/delayscapes
16 Gumbrecht 2004: 8

It has been a feed-backward effect of recording technologies that made it possible to perceive existing events as "live".[17] The tele-presence induced by electronic images in television news is different from the most determining auratic characteristic of the museum: "the necessary presence within it of objects, things which by their presence in the museum, claim a particular status [...]"[18] - in fact the status of real presence.[19]

But image transmission by the digital camera is not really telepresence any more. The recursive loop between technically mediatized art and "live" art is known from closed-circuit video installations already.

Motion analysis and the "present time window" in neurological terms

"Archiving presence" opens a temporal window of affective indeterminacy, "a zone between a 'not yet' and 'always already over'"[20]. In neurological terms, the brain does not store memory images or acoustic melodies respectively rhythms as such but rather operates with *Delta* codification: just the differences between waves are registered.

It is by intervention of measuring equipment like digital motion capturing that what appears like expressions of a continuous present dissolves ("analysis") into micro-intervals of quasi-musical motions. What looks and sounds like a transitive relation between a musician and his instrument, might not be a musical gesture at all but rather a "servo-mechanism" in cybernetic terms of signal communication between the animal and the machine.

Intermezzo: "live" transmission in radio and television

On a macro-temporal level of vehicle transport sensation, the intercontinental flight experience of "jet-lag" indicates a delayed, "deferred present", a differential time experience where time is experienced *transitively* while emerging in transition, an irritation of the present literally *on the fly*.[21]

On the micro-temporal level of tele-communicative signal transmission, "live" transmission is never immediate in its strict electro-physical sense. On the level of electro-magnetic waves, there is always a delay at work - the limit of the speed of light itself, as discovered by J. C. Maxwell in response to Michael Faraday's "invention" of the electro-magnetic induction effect.

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17 Philip Auslander, Liveness. Performance in a Mediatized Culture, 2nd ed., London (Routledge) 2008, 56
18 Silverstone 1992: 35
19 See George Steiner, Von realer Gegenwart. Hat unser Sprechen Inhalt?, Munich 1990
20 As expressed in the *abstract* for the symposium *Timing of Affect*, Academy of Media Arts, Cologne, 30 May - 1 June 2013
21 For an analysis of such phenomenological time, see Sara Scharma, In the Meantime. Temporality and Cultural Politics , Durham, NC (Duke University Press) 2014

Electro-magnetic induction itself is already a microphysical oscillation between delay and transfer. Martin Heidegger's notion of "ecstatic" temporality (*Being and time*, 1927) differs from time as succession, like the momentary event of the soccer goal transmitted in live television.[22] Here, the "Augenblick" corresponds with the ecstatic "now"[23], "realtime history" like Günter Schabowski's immediate (electro-phyiscally real) transmission of the (symbolic) "sofort", or Beckham's goal during the World Cup in Germany 2006 as "a perfect example of the relationship between events and their moments. <...> The goal, when it came, struck like a flash of lightning. There and gone in an instant. And yet everything was now transformed - an electrifying moment [...]"[24], *electrifying* in a media-literal sense, since: "The aliveness of tele-technologies is the effect of the power (energy) source that is the condition of their possibility; namenly electricity."[25] This is the Kantean and Foucault's *a priori* in times of technical signal transmission media.

The collapse of the Berlin Wall, in the night of November 9th, 1989, has been an effect of *non*-delayed televisual presence. At a press conference in East Berlin, the spokesmann of the ruling Socialist Unity Party of GDR (SED) Günter Schabowski was asked upon the enactment of the new unrestricted travelling opportunities for East German citizens. His verbally articulated answer "sofort" ("immediately") coincided with its electro-magnetically immediate, *live* signal transmission, resulting in an immediate run of East Berliners to the gates of the Berlin wall. The narrative sequence of events which is the traditional condition for historical events was compressed into almost no delay, faster than any administrative or military chain of communication could ever react.

According to Walter Benjamin's *Theses on the Notion of History*, dialectic history "flashes" like an images to be seen never again - indirectly a description of the electronic image. Just like phonographic signal recording, video transmission and recording can not but register even stillness as "moving" which is the physical nature of the time-signal and the rotating or scanning apparatus itself, performing a mathematical "integration" of the recorded movement. But Benjamin wrote this before video tape recording from television arrived; in fact since 1963 videotape machines (just like the subsequent video-disc) allowed for the *instant replay* of decisive moments in sporting events. The instant, once the temporal icon of pure present, became iterative; extended (or rather: distanced) presence by signal recording in fact transforms delay into archive. At the moment of the catastrophe seconds after launching the Challenger space shuttle in the US, "[...] television itself was on the scene - witness to the catastrophe. And the played and replayed image of the *Challenger* exploding [...] constant evidence of television´s compulsion to repeat - acts as a reminder not only of the catastrophic nature of the event but also of the capacity of television to record instantaneously, a reminder of the fact that television was *there*. The temporality of catastrophe is that of the instant."[26]

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22 See Paddy Scannell, Television and the Meaning of Life, Cambridge (Polity) 2014, 173 ff.
23 Scannell 2014: 188
24 Scannell 2014: 173
25 Scannell 2014: 48
26 Doane 1990: 231 f.

The irritation of the present by electronic media operates in the hidden mode; only subconsciously humans register micro-moments of delay which leads to subliminal irritations of sensation. This temporal secrecy erupts in telecommunicative moments when the live transmission of a soccer game on television is paralleled with its live report over radio where the latter is usually faster in signal transfer. When the ear has pre-processed the information already, it is easier for the eyes-coupled brain to process the visual immediacy of the event culinating in the dramatic soccer goal.

The scripted talk in radio and television was introduced against the risks of unsheltered unscripted commentary in live transmission and "breaking news".[27] Different from cinema-montage which allows for dramatical time order since it is a storage medium, electronic (signal-based media) coincide with the experience of contingency. René Thom's "theory of catastrophy" corresponds with the character of "breaking news" in television. The significance of the electronic media event is in its temporal immediacy, "where the referent becomes indissociable from the medium"[28] - signal transmission; recent German history when at a press conference on November 9th, 1989, the GDR speaker of the central government committee, Günter Schabowski, announced the "sofort" implementation of the new liberal travel licence for East Germans. Since this "sofort" spoken at an East Berlin press conference was technically transmitted "sofort" (immediatley) as a live signal by television and radio, it triggered the break of the Berlin Wall since it was faster than any political or military administration could react in real time.

The traumatic momentum is not restricted to referential "historical" incidences like the "nine-eleven" terrorist attack on New York in 2001 as televisual witnessing, but actually already results from the micro-shocks which is technologically induced in human media perception (See Doane 2002: 13 ff).

One effect of digital cinema, video and sound is that the "witnessing" on its most essential technological level looses its indexicality.

Until recently, radio and television, and nowadays mobile media "greatest technological success has been its ability to be there - both at home and ubiquous. "Hence the most catastrophic of technologocial catastrophes is the loss of the signal"[29].

(Mass-)Media-induced "traumatic" temporality

If "catastrophe does <...> always seem to have something to do with technology and its potential collapse"[30], the collapse of the TV image of

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27 Scannell 2014: 114
28 Mary Ann Doane, Information, Crisis, Catastrophe, in: Patricia Mellencamp (ed.), Logics of Television. Essays in cultural criticism, Bloomington / Indianapolis (Indiana UP) 1990, 222-239 (222)
29 Doane 1990: 238
30 Doane 1990: 229

Rumanean dictator Ceaucescu ("Trasmissione directa") has been the traumatic message of the medium itself.[31]

Trauma belongs to the essential experiences of technoculture; its defining characteristics is the disruption of time and space[32] Trauma arises with the technological signal recording and - transmitting media themselves (since photography); traumatic time is a non-historicisable experience (eventality), coupled with genuine media time (time-criticality). There is no past in media. Trauma is the non-archivable; its temporal figure is not (historical) narrative but repetition which lends itself to recording technologies.

In his analysis of the photographic moment, Walter Benjamin defines the camera's ability to arrest the ephemeral and the contingent: "The camera gave the moment a posthumous schock, as it were." With the moving photographic image, "perception in the form of shocks" was even established "as a formal principle"[33]. - which is montage. "The very rapidity of the changing images in film is potentially traumatic for the spectator and allows the cinema to *embody* something of the restructuration of modern perception."[34] Along with the French *Apparatus* media theory, such kind of non-discursive pratices is already embodied in the technical devices itself: in the mechanism of the intermittant image: "They have a knowledge effect."[35] "[...] contemporary media technologies serve as the major site wherein contemporary trauma is not just witnessed but actually produced and registreterd as traumatic in the first place."[36]

The techno-traumatic incident already occurred in the very first photographic recordings: taking out of a moment (or intervall) out of historical time, an ekstatic temporality, which "mechanically repeats what could never be repeated existentially"[37]. Once the singular "spark" of the apparent historical accident[38] as narrative or dramatic category coincides with technical lightning

31 See Farocki / Ujica, Videogramme einer Revolution, xxx
32 See as well the "Indoduction" by Mousoutzanis, ix-xix (xvii f.), in: New Media and the Politics of Online Communities, ed. by Aris Mousoutzanis / Daneil Riha, Oxford (Inter-Disciplinary Press) 2010 (in eBook format). See Aris Mousoutzanis, Cybertrauma and Technocultural Shock in Contemporary Media Culture, in: ibid., xxx-xxx
33 Walter Benjamin, On Some Motifs in Baudelaire, in: Illuminations, ed. Hannah Arendt, New York (Schocken) 1969, 174 f.
34 Mary Ann Doane, The Emergence of Cinematic Time. Modernity, Cintingency, the Archive, Cambridge, Mass. (Harvard Univ. Press) 2002, 15
35 Doane 2002: 21, referring to: Michel Foucault, History of Systems of Thought, ed. Donald E. Bouchard, Ithaca, N. Y. (Cornell UP) 1977, 200
36 Aris Mousoutzanis, Cybertrauma and Technocultural Shock in Contemporary Media Culture, in: same author / Danile Riha (eds.), New Media and the Politics of Online Communities, Oxford (Inter-Disciplinary Press) 2010 (in eBook format), 173-180 (*abstract*)
37 Roland Barthes, Camera Lucida. Reflections on Photography, New York (Hill & Wang) 1981:, 4
38 Walter Benjamin, A Short History of Photography [*1931], in: A. Trachtenberg (ed.), Classical Essays in Photography, New Haven (Leete's Island Books) 1980, 199-216 (202)

(the photographic flash or other light-recording), it is transformed into media time, culminating with the electronic image where the cathode ray image is a bombardment of electric sparks indeed. "Exstatic time breaks with the ordinay conception of time as a succession of 'now' moments and presents us with *truly historic* time: 'moments, when a minute lats a lifetime, or when a week seems to fly by in next to no time. This is what Heidegger calls 'ecstatic temporality', or time taking place in its authentic moment of ek-sistence'."[39]

Catastrophe does not only enact a time different from conventional historical exprience but is ecstatic towards the parameter of time itself, representing „that which cannot be contained within <...> an ordering of temporality"[40]. The media situation goes with an "acceleration of its temporality to default 'real-time' reporting"[41].

Not the visual "content" of the representation as such but its temporal instantaneity is the traumatizing momentum. Therefore TV live transmission of the 9/11 attack has been *participative* itself, as Paul Virilio commented.[42]

Crisis-readiness roots in communication engineering, since both Wiener and Shannon treated the thread of an enemy air plane approaching its target and the correlative anti-aircraft artillery as an act of "communication" itself

The contemporary routine background condition of persistent crisis-readiness[43] is rooted in the time-critical conditions of media technologies themselves. The category of crisis has traditionally been bound to human agency[44]; in times of electronic signal processing crisis witnessing is not an exclusive human capacity any more. The permanent state of alert commonly associated with "live" broadcasting and "breaking news" editing is an emanation of the essence of electronic media: the speed electro-magnetic waves and the real-time paradigm in digital signal processing. The focus thus shifts from the human witness augmented by mass media to an analysis of signal and data processing *within* the technologies involved.[45] The technologically induced witness affect

39 Lilie Chouliarki, The Spectatorship of Suffering, London et al. (SAGE) 2006, 158, referring to: C. Barker, Alain Badious. A Cricital Introduction, London (Pluto) 2002, 75
40 Doane 1990: 233
41 Frosh / Pinchevski 2009: 303
42 "Es gibt eine Mitschuld der Medien, auch wenn sie eine indirekte ist. <...> Zur Diskussion stehen dabei keineswegs die Fotos von einem Ereignis, sondern die Livebilder." Der Mann, der am 11. September nicht vor dem Fernseher saß: Ein Interview (Jürg Altwegg) mit Paul Virilio, in: Frankfurter Allgemeine Zeitung, 20.09.2001, Nr. 219, 49
43 Paul Frosh / Amit Pinchevski, Crisis-Readiness and Media Witnessing, in: The Communication Review, vol. 12 no. 3 (2009), 295-304 (*abstract*)
44 M. A. Doane, Information, crisis, catastrophe. In P. Mellencamp (ed.), Logics of television: Essays in cultural critcism, Bloomington, Indiana and London (Indiana University Press and the British Film Institute) 1990, 222–239 (223)
45 As encompassed by the definition of *media witnessing* as "the witnessing performed in, by, and through the media ": Frosh / Pinchevski 2009: 296

results in "crisis-emotions among those who were not physically present at the event but nevertheless feel themselves affected by it"[46].

Different from ultra-time-sensitive measuring devices, there is (at least for humans) no perceptible difference between the "live" transfer of electric signals and their replay from from phonograph, magnetic audio or video tape, or digital storage disc. Such replay does not come from memory but is signal-technical "re-presencing"[47].

The affect of the *instant* is not simply a discursive effect or a phenomenological perception but the temporal essence of electro-magnetic wave propagation itself: almost no D*t*. When Walter Benjamin defines the singularity of the instant as "the spark of accident"[48], this spark is no metaphor but operates literally in electronic media - a pure function of technological temporality (*tempaura*lity)

Different from electronic live transmission in radio and television, cinematographic images can not testify real time, since the time of recording and the time of replay are separate. The moment of projection has no inherent relation to the temporal scene (chronosphere) caught in the images[49]

Instantly recording the present

Against the user claim for immediately fetching all kind of data, restricted access has been an old archival virtue of temporal defer to be rediscovered - with a view on the essence of academic university as well. Online access to data results in a culture of "immediacy, whereas traditional (academic) knowledge require delay in reflective thinking.[50]

There has been a remarkable media-technologically induced difference between the situation of people waiting at St. Peter's Cathedral in Rome for the new pope to be announced in 2005 (Benedict XVI) and in 2013 (Francesco)[51], from continuous eye-witnessing of the present moment to time-discrete "I-

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46 Frosh / Pinchevski 2009: 301

47 On that term see Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333

48 Walter Benjamin, (1931/1980). A short history of photography. In A. Trachtenberg
(Ed.), Classical Essays in Photography (pp. 199–216). New Haven: Leete's
Island Books. p. 202

49 See Kerstin Volland, Zeitspiele. Inszenierung des Temporalen bei Bergson, Deleuze und Lynch, Wiesbaden (GWV Fachverlage) 2009, 92

50 Marquard Smith, Theses on the Philosophy of History: The Work of Research in the Age of Digital Searchability and Distributability, in: Journal of Visual Culture, vol. 12 (2013), 375-403 (380)

51An argument by Angela Maiello (PhD student, University of Palermo), research presentation at the colloquium *Medien, die wir meinen*, Humboldt University Berlin, summer 2013

(pad-augmented)witnessing". Virtual photo-testimony is a kind of macro-sampling of the present (which micro-technologically happens in the sample-and-hold mechanism of analog-to-digital conversion itself).

Different from the archive which is symbolical order, recorded by symbols (alphabet), thus: spatial orders, audio-visual media record signals which are physically functions of time; this becomes apparent in, e. g., Gordon Bell's *My Life Project* recording project, operated by the permanently worn data eye-glass. When these are being re-played, our senses are affected, in a non-historical way. There is no memory here, presence happens, like any electronic re-play is dynamic. Instead of psychoanalytic trauma-research now: an analysis of the techno-traumatic momentum (traumatic irritations of re-presencing induced by analog and digital techologies, such as the phonograph once and the real-time, that is: techno-archival present in Web 2.0 cache memories of short-time data buffers and registers.

Duration is the conceptual contrast, as defined in Henri Bergson's *Creative Evolution*: "For our duration is not merely one instant replacing another; it it were, there would never be anything but the present [...]. [...] Memory [...] is not a faculty of [...] inscribing them [sc. recollections] in a register." There is no register, different from stored-program computing (the familiar von-Neuman architecture) where the register figures centrally within the CPU to operate at all.

Another case is Finnish media-arist Erkki Kurenniemi's audio-visual self-recordings over decades, from analog to digital devices.[52] "We would make a mistake if we think that, in contrast to Erkki's attitude towards presence, we could refer to a 'normal' sense of presence in the present: to an unmediated, integral presence. Nothing as such exists either. We are always anticipating and deferring, missing the presence. But if we all 'live with it', Erkki has articulated his life around it and explored the full consequences of the utopia of a divisible present in both existential and technological terms. Films, images and videos, here, are time capsules. But not of any time, but the time of a deferred, diminished presence. To begin an archive based on documents of such a nature means first to negotiate a debt. An archive would need to give back the presence that Erkki took away from his life moment by moment."[53]

The new immediacy of archival time in terms of *online* accessability and instant re-play may be compared to a situation from the area of visual recording of movement. The production and projection of documentary film since the beginnings of cinematography had been a rather heavy and slow apparatus-depended process, and copies were expensive. Around 1968, with the arrival of the first Sony "portapacs" as portable video recorders (used, e. g., by Nam June

52 See W. E., E-Kurenniemics: Becoming Archive in Electronic Devices, in: Joasia Krysa / Jussi Parikka (eds.), Writing and Unwriting (Media) Art History. Erkki Kurenniemi in 2048, Cambridge, Mass. (MIT Press) 2014, 203-212
53 Constant, Erkki Kurenniemi (In 2048) (preliminary work towards) an online archive; *online* http://kurenniemi.activearchives.org

Paik), "meant a breakthrough, because you could immediately play back what you had recorded."[54]

Archives have always been summoned "to give back time" - which requires that they first withdraw data from the temporal economy of the present (as represented in the practice of immediate access on the Internet). "But what if they are asked to give back presence?" <Constant ibid.>.

Erkki Kurennimi's self-recording (which has been pornographic to some extent) lingers at the borderline between the obsession of memoryless consumtion of presence and the pleasures of its immediate recording.

On Douglas Rushkoff, *Present Shock*

Technological control over time becomes universal in turingmachine time.

"[N]o matter how precisely we can count our milliseconds, neither our bodies nor our businesses are proving as programmable as our computers. [...] While our technologies may be evolving as fast as we can imagine new ones, we humans and our culture evolved over millennia and are slower to adapt. The body is based on hundreds, perhaps thousands, of different clocks, syncing to everything from the sun and moon to levels of violence and available water. We can't simply declare noon to be midnight and expect our body to conform to the new scheme as if it were a Google Calendar resetting to a new time zone. Neither can we force our businesses to conform to an always-on ethos when the people we work with and for are still obeying a more deeply embedded temporal scheme."[55]

Communicational connectivity of being always-on is an affordance of electronic media. But only when combined with mathematical intelligence, the punctual present explodes into the multitude of real-times.

Rushkoff defines presentism as a result of the pervasiveness of digital technology where everything is "now", but the very term *now* still continues a metaphysical concept of the present. What really puts the term into quotation marks is real-time signal processing which in fact achieves a dissimulation of the "now" itself.

"Each moment is a new decision point more than it is part of some journey through time. In digital media, we are participating in a real-time event, not being taken along some linear path."[56] What articulates itself through

54 Tjebbe van Tijen, We no longer collect the Carrier but the Information, interviewed by Geert Lovink, in: MediaMatic 8#1
55 Adapted from Douglas Rushkoff, Present Shock. When Everything Happens Now, New York (Penguin) 2013; http://www.rushkoff.com/blog/2013/3/14/wall-street-journal-adaptation-from-present-shock.html; accessed November 4, 2013
56 Rushkoff, in: Andrea Huspeni, "For Douglas Rushkoff the future is now — and that's the problem", edited and condensed interview, March 21, 2013, in: PandoDaily; http://pandodaily.com/2013/03/21/embargo-321-how-present-shock-is-shaking-up-the-startup-world; accessed November 4, 2013

Rushkoff's *persona* is the message of hypertextual Internet communication topology itself.

The present condition, as analyzed by Rushkoff, has become con-temporary in its literal sense: living in real-times, communicating instantaneously, co-existing simultaneously, being always-on, in post linear time - even timeless.

At the same time, the computational condition of data-processing in the present is de-archiving: moving programs and data from the hard drive to the Random Access Memory. Random access to intermediary storage devices is a mode of fuzzy present as opposed to the Read Only Memory frame of the conventional nation-state.

Rushkoff defines the "present shock" as a kind of timelessness. "We are becoming an a-historical society, with no sense of story, [...]. We're going from a world where we find meaning over time to one where we do it in the moment. It's a digital society, where everything is a sample or a duration."[57] Is culture prepared for digesting this tempo-real irritation of its traditional symbolic time order, or will it results in an ongoing traumatic disorder of times out of joint? "[...] we begin with some wobble — the kinds of initial reactions to a presentist, real-time world. But slowly, over time, we become more mature in our ability to deal with this new temporal environment" (ibid.).

Between storage and interaction with the present: Time-critical signal manipulation of presence (magnetic tape, video recording)

What has been a philosophical (Bergson) or historical (Braudel, Koselleck) notion of temporal layers, now becomes firmly grounded[58] in magnet tape recording (sound, video, data storage).[59] In World War Two, the allied armies had been puzzled by apparent live converts transmitted by German radio in the middle of the night - which in fact was time-shifted radio broadcasting from Berlin, due to magnetophonic recording in high signal fidelity which resulted in the phenomenology of "live" hearing. Only a close reading of a specific technological operation - the ultra-frequency pre-magnetisation of the tape immediately before the recording head - explains for this tempo*real* irritation of human perception of the present. Soon after German capitulation, US army officer Jack Mullin introduced two such magnetophones to AMPEX company. At the East coast, Bing Crosby's radio studio production had to master the problem of time zones for broadcasting in USA; the solution was either repeated "live" broadcasting for different times zones (while the speed of electro-magnetic waves in broadcasting remains the same), or pre-recorded production which can then be at temporal random be re-played in different

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57 Rushkoff, in: Huspeni 2013
58 *Erdung* is a technical term in German electro-engineering, giving a precise sense to media-archaeological analysis. *Grounding* indicates that circuits in hardware - the "mass" - have to be connected with the ground, just like the antenna in ancient radios to avoid a lightning strike destroying the whole apparatus.
59 See Friedrich Engell / Gerhard Kuper / Frank Bell, Zeitschichten. Magnetbandtechnik als Kulturträger, Potsdam 2008

times (the reverse of Random Access Memory in computing). The magnetophone allowed for the "live" recording of the present event, then for time-shifted re-play - undoing the linear time line, while not undoing the "time object" of the technical device itself. In mass media production, this has resulted in a chrono-technical hybrid: so-called "live-on-tape".

A generation before, John Logie Baird had invented "Phonovision" for recording his electro-mechanically produced television signals on grammophone discs, while German television developed the intermediary film procedure ("Zwischenfilmverfahren") for broadcasting the Olympic games in Berlin almost in the live mode: In order to capture events in daylight, only celluloid recording was sufficiently sensitive (therefore not allowing for immediate actual news broadcasting); such film sequences were not meant for post-production or archiving but developed immediately after the event to be coupled with an electronic camera in the television automobile - with the photo-chemical emulsion being washed out immediately after for re-filming. This is the reverse of *kinescope recording* directly from monitor on 16mm film for storing electroic images before video tape technology.

The video recorder in private usage resulted in a "transition from unidirectional time flow (from present to future) to multidrectional time flow"[60], brought to its technical point with the *start-over button*. "As long as a particular program is being broadcast, it is possible to start it over again", thus echoing synchronic and asynchroni broadcasting schedules.[61] Such is time axis manipulation in analog video cassette recording. "To rewind means to reverse the direction of a roll of magnetic tape or various types of film. This term has outlived" - in a kind of technosemantic gap - "physical spool-based media and is now also applied to digital media" <ibid.>. What would media-based autobiographical re-collection as dramatized in Samuel Beckett's *Krapp's Last Tape* look like today?

Today, digital video recording is an almost dialectic interlacing of cinematography on celluloid and electronic live image transmission:

"In the convergence between a repetition and a renewal lies the tendency to archive while bringing forward: past and present instantly simultaneous in the fragmented image. While it loops the past, the digital creates an image of an archival strategy where time passed becomes constantly accessible for the future. [...] reality's duration seems to have become a continuous stream of information potentially open for another time."[62]

Digital recording does not require the delay time of chemically "developing" the negative on celluloid any more but renders immediate monitoring functions. Different from the well-acquainted monitor function known from video camera recording and live television, the digital moving image recording allows for immediate intervention. "[D]igital equipment has been built on this ability of storing information efficiently for the purpose of immediate and direct access

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60 Mira Moshe, Media Time Squeezing: The Privatization of the Media Time Sphere, in: Television & New Media 13(1), 2012, 68-86 (74)
61 Moshe 2012: 74
62 Markos Hadjioannou, From Light to Byte. Toward an Ethics of Digital Cinema, Minneapolis (Univ. of Minnesota Pr.) 2012, 174

to, and interaction with, it. What is stored on a hard drive are data that can be retrieved via a number of points or routes as made possible by the RAM"[63], governed by the agency of the operative algorithm and resulting in an algorhythmicized present.[64]

Archival manipulation of the already present: Real-time editing

Visible Cities, created in 2009, is a webdocumentary and multi-screen installation, developed by the LAT-23 collective in Sao Paolo, Brazil.[65] "The online version generates automatic clips of 8 minutes, by randomly mixing pre-recorded and live footage from webcams organized in sets of pre-defined tags and listed on the project's database. The installation version fill a darkened room with 5 monitors that display the live cameras, organized according to a collection of tags periodically sorted. The premise is that intermittent images of a place result in a situation opposite to the one to be expected."[66] The automatic editing process creates films that evolve in real-time from algorithmic decisions:

"Visible Cities aims to subvert the logic of filming and editing typical of cinema and video, with procedures of capturing online signals and tagging the resulting materials. The goal is to produce films in which live footage produce unexpected results. It is impossible to anticipate what the online webcams embedded on the project's database will display. By aproximating them by a combination of tagging and spatial proximity, the piece stimulates arbitrary relationships between distant places."[67]

The footage is already existing, but the spatial relations and order in which it will be displayed is generated every time the user clicks on the play button. Like George Legrady's installation *Pockets full of Memories*, this kind of Self-Organizing Map relates to genuine computer art which is generative aesthetics (Max Bense et al.). When the images are edited through programming rules, the algorithmic collage replaces narrative dramatization.

Media analysis of the present in high frequency

It takes an observational temporal difference to clearly separate actual news (information) from the redundant archival accomulation of data from the past.

On the final announcement in the radio play *Vergiss nie, was du gesehen hast*, broadcasted 24th of June, 2013, at Deutschlandradio Kultur channel, the editor

63 Hadjioannou 2012: 201
64 Shintaro Miyazaki, Das Algorhythmische. Microsounds an der Schwelle zwischen Klang und Rhythmus, in: Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009
65 Denise Agassi, Marcus Bastos, Claudio Bueno and Nacho Durán
66 Marcus Bastos, Eventuality: Designing Real Time. Lecture Notes, in: Computer Society (Proceedings of Human Interaction 2014 Conference), Heidelberg (Springer), 2014
67 Bastos 2014: "Eventuality"

"m" writes on 26 June: "The news message at the end of the play" - an US-American bomb attack on Iraq nuclear plants -" of course, is part of the fictive drama and the end of a bitter story by the Finnish author Illka Remes." What in a dramaturgical con"text" serves as a "authentification signal" is not identifyable as fictive in the time-critical context, when listened to just as final part of the radio play itself - which then sounds like "breaking news". Instead of the cultural / semiotic con"text" there is a temporal context, better called: synchrony, which - when interrupted - creates the traumatic intrusions of the *War of the Worlds* effect achieved rather in the notorious radio play adaption (Orson Welles) than in H. G. Wells' literary version itself.

A culture of "TV on demand" in the Internet (based on the electronic archive) replaces live TV. Even streaming media involve micro-temporal storage (the necessity of buffering a whole frame, which opens a juridical door or copyright violation claims).

It was in 2006 that the BBC ("The Future of Television is on demand") based on a digital archive allowed for "seven day catch up", followed by ZDF in Germany (*Mediathek*) soon after.[68]

From "archiving" presence to delayed presence (a question of storage theory, the question arises: When does "transmission" end and "storing" start?: A radio conversion broadcasted on German FM radio Kulturradio in the morning of 24th October 2013 at around 8.25 a.m. was finally supplied with the information that the conversation had been recorded an hour ago. Ironically, the talk was about the supposed interception of chancelor Angela Merkel's private cell phone by US intelligence service NSA.

As pointed out by Timothy Barker[69], cinema separates movement into stills, television fragments images into discontinuous lines and the digital computer converts signals into bits. This results in new, discrete temporalities which on the discursive surface are documented by performative practice ("social media").

High-frequency uploads and "streaming media" *online* religates the formerly separate ("secret") archive to the almost immediate present (depending simply on bandwith and channel coding conditions). Formost the financial markets are now based on the time-scale of high frequency computing, resulting in fluctuations and rhythms which nano-temporally subvert the notion of the present moment itself. The trading floor turns into media theatre. Media and

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68 See Günther Schatter, Zeitsouveränität und elektronisch Medien. Das Programm und seine schrittweise Selbstauflösung, in: Klaus-Dieter Felsmann (ed.), Der Rezipient im Spannungsfeld von Zeit und Medien, Munich (kopaed) 2008, 53-67 (63)

69 See Timothy Scott Barker, Re-composing the Digital Present, in: Contemporaneity: Historical Presence in Visual Culture, vol. 1, no. 1 (2011), 88-104; same author: Time and the Digital. Connecting Technology, Aesthetics, and a process Philosophy of Time, Hannover, New Hampshire (Darmouth College Press) 2012

cultural theory has so far attempted to account for such media-induced temporalities in terms of acceleration and speed.[70]

In algorithmic computing, there is a radically new quality of the way times are operationally engineered - what Boris Groys refers to as perpetual series of presents.[71] The symbolic order of cultural time which has so far been based on the clearly separated temporal categories past, present, and future, implodes into operative anachronism. Technological devices that sample the present techno-mathematically "analyse" time through Fourier Transform.

In the media-economy of high frequency trading, the beast are time-beasts. The time lense shifts from macro-temporal economical cycles to micro-temporal intervals. At places such as the virtual Stock Exchange, time-critial temporalities become econimical tempor*e*alties. High Frequency Trading operates with time-"hiding" purposes like these, just like perceptual experiments in the 1960s: smuggling ultra-short moments of Coca Cola advertising into a regular TV movie, not consciously noticed by the viewer. Time-critical economy works especially in businesses.

The algorithmic "Markov present"

It is in the very time-critical nature of stored-program computing (in the so-called von-Neumann architecture) that the present infinitesimally implodes. When *in being*, a techno-logically implemented algorithm makes the digital computer operate in multiple cycling-units, while at the same time adhering to its "one step at a time" imperative of linear (as opposed to parallel) processing. There is no actual present moment until the program comes to an result. The present rather has to be induced by observation, e. g. in the debugging mode where the actual computing can be frozen into a single step or machinic "state" (Turing's term[72]).

From a psychophysical experiment with a quantum light source that generates discrete states of light, it resulted that humans can detect a single-photon incident on the cornea with a probability significantly above chance. "[T]he probability of reporting a single photon is modulated by the presence of an earlier photon, suggesting a priming process that temporarily enhances the effective gain of the visual system on the timescale of seconds"[73]

- which almost matches the criterion of a first-order Markov process in probability theory. Such a stochastic process is almost memoryless: "[A] process satisfies the Markov property if one can make predictions for the future

70 See R. Hassan, Empires of Speed, Leiden (Brill) 2009

71 Boris Groys, Comrades of Time, in: D. Hauptmann / W. Neidich, Cognitive Architecture, Rotterdam (010 Publishers) 2009

72 Alan Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, in: Proceedings of the London Mathematical Society (2), 42(3), 1936, 230-265; 43(7), 1937, 544-546

73 "Direct detection of a single photon by humans", in: Nature Communications 7, article number: 12172, doi:10.1038/ncomms12172 (retrieved 25 July, 2016), abstract

of the process based solely on its present state just as well as one could knowing the process's full history. i.e., conditional on the present state of the system, its future and past are independent."[74] Therefore a Markov process "can be used to model a random sytem that changes states according to a transition rule that only depends on the current state" <ibid.> - which is a true existence in the present, living in discreet states as a function of dynamic, self-adaptive re-configurations of the cognitive Turing Machine "program" wiring.

Traditional and posthuman understanding of affect

The cybernetical assumption of co-original (therefore analogous) signal processing in animals and machines (Norbert Wiener) results in combined human-machine systems. The cybernetic organism incorporates exogeneous components extending the self-regulatory control function in order to adapt it to new environments."[75] From this derives a guiding hypothesis for the current project: This cybernetical assumption counts for the *temporal coupling* of human and (chrono-)techologies as well. Once human perception is "tightly" (Fritz Heider / Niklas Luhman) coupled to a technical medium, it is subject to technological tempor(e)alities; aptly Henri Bergson described the interlacing of present perception and past recollections as electric circuit.[76] The affordance (Heidegger's *Zuhandenheit*) of new time technologies not only shapes but generates temporal consciousness. When humans are in the Internet browsing state, memory there is not past, but a spatio-temporal latency.

Different from Henri Bergson, Gilles Deleuze detaches the affect from the subject-body and rather locates it within the technological procedure[77] - which results in a techno-trauma indeed. This becomes evident in electronic imagery and the "scanning finger" (McLuhan) of the cathode tube ray in analog television and video as such: "It addresses our nervous system directly. It

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74 Retrieved from "https://en.wikipedia.org/w/index.php?title=Markov_process&oldid=712058457", referring to the entry "Markov process (mathematics)" in the Britannica Online Encyclopedia; accessed 25 July, 2016
75Paul N. Edwards, The Closed World. Computers and the Politics of Discourse in Cold War America, Boston, Mass. (MIT) xxx, chap. 9, note 1 (referring to Manfred Clynes / Nathan S. Cline, Cyborgs and Space, in: Astronautics, September 1960)
76 "Tatsächlich beginnt sie [sc. die Erinnerung, *memory*] ja erst dann nicht nur mit der Gegenwart zu `verwachsen´, sondern mit ihr eine Art *Stromkreis* zu installieren, in dem das Erscheinungsbild auf das Wahrnehmungsbild verweist und umgekehrt." Gilles Deleuze, Bergson zur Einführung, ed. and transl. Martin Weinmann, Hamburg (Junius) 1989, 87, referring to Bergson's *Matière et Mémoire*
77 See Mark B. N. Hansen, New Philosophy for New Media, 32 f. Referring to current neuro science, Hansen insists that it is the bodily perfection which enframes and modulates the (merely technical) information.

creates a being of the sensation that exits in itself and reveals to us a state of becoming-nonhuman"[78] in terms of a "pre-personal perception"[79].

"[A]n understanding of the messy materialities of affective regimes stems largely from nineteenth-century physiology, experimental psychology and a variety of scientific and experimental measurements [...]. In other words, there is a media-archaeological side to the notion of affect as well."[80]

The micro-temporal momentum of affect

Affect is a signalling of a non-discursive, non-narrative traumatic timing. The co-origin of trauma studies (Freud) and technical cinematography around 1900 is not coincidental in itself. To formulate it rather in engineering than in psychological terms, there is human perception of signals in the Low Frequency Band of which the mind is consciously aware (like audio signals between 16 Hz and around 16 kHz), as opposed to signals in the High Frequency Band which are there but not perceivable for human senses - a sublime existence. There are time events (and their manipulations) of which humans are simply not aware, just like radio and television transmission as technical event (carrier frequencies). But still they *result* in affective modulations of human sensation - indirectly, as *sublime tempor(e)ality*.

The tempor(e)ality of a deferred present becomes evident from experiments on the formative interval of perception, a micro-temporal lag between the brain activity initiating a movement and the conscious registering of the decision to act. The notion of delay, for technologies of telepresence, is a rather alien idea; it is the metaphysics of the instant which buttresses their contemporaneity. Regarding the techno-traumatic tempor(e)ality flashing from electronic television is bound to the temporality, the difference between analog and digital becomes literally "decisive", since sudden change (catastrophe) corresponds with digital switching: "The time proper to catastrophe might be thought of as compatible with that of the digital watch where time is cut off from any sense of analogical continuity, and the connection between moments is severed. One is faced only with the time of the instant - isolated and alone."[81] This is true, though, since the implementation of the escapement-controlled mechanically wheeled clock.

Technologically induced micro-traumatic moments escalate with the rupture between mechanical cinematography and electronic (analogue) images: "With film, the brain does not 'fill in' the images on the screen - it fills in the motion between images. With television, the brain must fill in (or recall) 999.999 percent of the image at any given moment, since the full image is never

78 Mark Hansen, Deleuze and the Three Powers of Literature and Philosophy, in: Deleuze and Guattari. Critical Assessments of Leading Philosophers, ed-. Gary Genosko, Londpon / new York (Routledge) 2001, 207-222 (216)

79 Claire Colebrook, Gilles Deleuze, London (Routledge) 2002, 38

80 Jussi Parikka, What is Media Archaeology?, Cambridge / Malden, CA (Polity Press) 2012, "Introduction", 30

81 Doane 1990: 238, note 3

present on the screen."[82] The "given moment" is time-"data"; absence is being micro-temporalized, towards the "tempo-real".

Affect is not only a mode of temporal experience, but itself a radically time-critical form of perception. According to Brian Massumi, affect precedes consciousness within human signal processing, as demonstrated by registering an electric impulse on the skin.[83] Thus a disruptive gap between affective and conscious ("thoughful") perception of one and the same micro-event takes place, resulting in an affective/cognitive temporal dissonance - in fact the traumatic tempo-momentum.

Once photography, the first autonomous media agency in its modern sense, became subject of the archive, the sense-affective, presence-generating power[84] of signal-based media cuts short the distance which is a prerequisite for *historical* analysis, in favor of mnemonic immediacy - the "electric" moment, a shock for the affective experience of temporal presence and past.

It has been Hermann von Helmholtz who detected that the run-time (speed of progagation) of signals in the motoric nerves of a frog counts around 24 meter/sec. This speed recalls a synchronization problem within humans, when technical audio-visual synchronicity might lead to irritation when compared to physical signal run-times in real nature[85]; a lightning stroke is seen more immediate than the accompanying thunder is heard. For the temporal domain of human perception, the media psychologist Herta Sturm once experimentally explored that while every day perception which always includes a slight temporal delay of reaction involving a kind of inner, subvocal speech[86], electronic media force their audience into immediate affection. *Immedia* interfaces deprive humans of their natural chance of delayed perception. Does nothing or everything happen within this half-second? Electronic immediacy, the almost missing micro-temporal gap, results in asynchronicity in signal processing time regarding humans on the one hand and electronic machines on the other, a difference in phase delay of signal transfer between technology and human physiology. But quasi-technological timing can be detected within human neuroprocessing itself, a kind of chrono-engineering. Pre-emptive activity is what apparently is stimulated in the pre-frontal cortex of the brain which does not simply react to incoming sensations but time-critically tends to anticipation (familiar from the difference between "live" and "real-time" signal transmission within communication media).

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82 Tony Schwartz, The Responsive Chord, Garden City, N. Y. (Anchor) 1974, 16

83 `Brian Massumi, Parables for the Virtual, Durham / London (Duke UP) 2002, 28f; see Barker 2012, 87`

84 See Hans Ulrich Gumbrecht, Production of Presence. What Meaning Cannot Convey, Stanford University Press 2004

85 See Uwe Sander, Die "fehlende Halbsekunde", in: Handbuch Medienpädagogik, Berlin / Heidelberg / New York (Springer) 2008, 290-293 (292)

86 Hertha Sturm, Wahrnehmung und Fernsehen: Die fehlende Halbsekunde. Plädoyer für eine zuschauerfreundliche Mediendramaturgie, in: Media Perspektiven 1/84, 58-65 (61)

"The word *communication* will be used here in a very broad sense to include all the procedures by which one mind may affect another. This, of course, involves not only written and oral speech, but also music, the pictorial arts, the theatre, the ballet, and in fact all human behavior. In some connections it may be desirable to use a still broader definition of communication, namely, one which would include the procedures by means of which one mechanism (say automatic equipment to track an airplane and compute its probable future positions) affects another mechanism (say a guided missile chasing this airplane)."[87]

A perceptual gap opens between the actual moment of the audio track and the visual frame in cinematography: introducing a loop which allows for the pre-cursive "reading" (by photo-cell) of the audio track on the film reel. Between the run-time of audio-through-air and visual emanation reflected from the screen opens a techno-traumatic micro-temporal gap (that is, induced by a technical asynchronicity).

TempoR(e)alities and "The Crannies of the Present" (Massumi)

The delayed present unfolds as a function between the techically mediated and the immediate. "Journalism" in the media-archaeological sense not only refers to the French *jour*, the day-to-day reports in the early Medieval Annalist tradition, but as well to the chrono-technical rhythm of the printing press.

According to Freud's definition, both affect and trauma break through the cognitive "Reizschutz" of symbolically ordered time which surrounds human perception. If taken literally, Freud's expression of the psychic "apparatus" corresponds with media in techno-logical resonance. From there derives the psycho-technological power of media - the techno-trauma. The potential of media is the technological real, resulting in specific forms and experiences of tempor(e)ality.

Even if "tele-vision" seems to indicate that the scopic regime is remote: perception from afar by definition, optical sensation itself is based on electro-magnetic waves which reach the human eye almost instantaneously. Human perception - even if wachting a video recording - is always in the present, but in different audio-visual ways / waves. TV is always "in the now" (from the camera and brodcasting perspective); with online communication media, the receiver as well is always "on". Already TV "live" transmission (on the signal side) provided for synchronicity in time, a being-there-in-time (while not in space), in decisive difference to cinematography which is a storage medium, re-prjecting an always delayed present - even with a hrinking difference in the *Zwischenfilmverfahren* of German TV on occasion of the Olympiad 1936 in Berlin.

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87 Warren Weaver, Recent Contributions to the Mathematical Theory of Communication, in: Claude Shannon / same author, The Mathematical Theory of Communication, Urbana (University of Illinois Press) 1964, 1

A critical moment happened at the Riga documentary film festival in 2001 on September 11th, when after watching a film projection in the cinema theatre, the audience was led for a coffee break into the adjacent conference room. There a TV monitor showed the puzzling images of a collapsing World Trade Tower. In the TV live coverage, the electronic medium came "to itself" (in Hegelian terms). On that Tuesday, the looped CNN "breaking news" interrupted the filmic event - breaking the cinematic situation by the TV apparatus.

In analogy to the "optical unconscious" identified by Walter Benjamin in relation to the camera lense, there is the "temporal unconscious" as well. Time-critical analysis focuses of the *arché* of the signal event itself as incipient actions, known from electro-acoustic analysis of the transitional "attack" in striking a musical tone, or the flashing cinematographic image. Such a temporal event does not necessarily unfold in a chronological order. The integration of the past with the here-and-now of the present, and the immediate becoming-past of the present moment ("the infra-instant", according to Brian Massumi) are "differential aspects of the same integral enactment"[88].

New "shapes of time"

On the scene of human culture, a new drama gets into focus: the techno-logically induced *chronopoetics* of microtemporal processes. Both in neuroscience and in studies of electronic and digital technologies, the analysis of time-critical action develops into an epistemology which radically challenges the traditionally familiar terms of emphatic time, with a shifting emphasis towards the non-linear, stepwise sequential, loop-folded, algo-"rhythmic" events. There is a privileged affinity between sonic tempor(e)alities and time-critical, "timely" media.[89]

Electronic media tempor(e)alty: "acoustic space" (McLuhan)

Sonicity for the analog electronic media epoque has been identified by Marshall McLuhan. The wall painting created by René Cera, Pied Pipers All (1969), for McLuhan's seminar room at the university campus in Toronto[90], in a psychodelic manner unreveals the television image as a sonic event. Whatever its apparent content, the tempo-real message of electronic media is "acoustic" in McLuhans sense of a different temporality: "[...] he argued that electronic media were

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88 As expressed by Brian Massumi, The Crannies of the Present, lecture at the Sawyer Seminar, Harvard University, end of April, 2014

89 The English adverb *timely* correponds to German "rechtzeitig, zeitgemäß, fristgerecht, frühzeitig"; see http://www.dict.cc/englisch-deutsch/timely.html, accessed September 8, 2014

90 See Fig. 3 in: Peter Bexte, xxx, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (eds.), McLuhan neu lesen, Bielefeld (transcript) 2008, 323-xxx (331). Photo: Derrick de Kerckhove; *online*: http://www.greatpast.utoronto.ca/GalleryOfImages/VirtualMuseumArti facts/PiedPipers.asp; accessed September 2nd, 2014

submerging us in this acoustic environment, with its own language of affect and subjectivity. Acoustic space isn't limited to a world of music or sound"; the environment of electronic media itself engenders this way of organizing and perceiving chronospheres.[91]

But the digitally modulated (PCM) electrosphere of today differs from this radiosonic (AM) metaphor. With digital numbers, central characteristics of what McLuhan diagnosed for the printing press age have returned, thus bracketing the age of analog electronic (mass) media as a interplay of modernity. In a dialectric synthesis, mobile digital telecommunication is now combined with the characteristics of "acoustic space" which is simultaneity. According to Marshall McLuhan's *Media Log*, "[s]imultaneity is related to telegraph, as the telegraph to math and physics."[92] But this discrete simultaneity is of a different kind. "Now, Internet 'radio' isn't radio; it does not exploit the spectrum, and that is a big difference"[93] - just like the difference between music recorded in vinyl grooves and its Compact Disc inscription. Close analysis reveals bit streams which allow for information theory, thereby: mathematical intelligence to control the event of electro-magnetic signal transmission. This happens in sublime manipulation on the micro-temporal level. Even if (according to the Sampling Theorem) human perception might not even notice the difference between a hight definition analog television image and its digital equivalent, ontologically this image has transformed into a different time-object once the critical perspective of the "receiver" is not humans but technologies themselves.

The sonicistic sphere in McLuhan's sense is (almost) simultaneous instead of time-linear: "Acoustic space is capable of simultaneity, superimpositon, and nonlinearity, but above all, it resonates. 'Resonance' can be seen as a form of causality, of course, but its causality is very different than that associated with visual space [...]."[94]

Through resonance in a physical - not symbolically coded - system, micro-events can cause distant objects to communicate - close to time-tunneling and Tesla-like energy transfer.

Sound is not just mechanical attacks, vibrations to the ear or aesthetic pleasure for the brain (von Helmholtz) but adressing the human (pseudo-)sense of temporality. The true message of sound as event is processual time. The "tuning of the world" (Schafer 1977) is a *timing* of the world as well. What looks physical (acoustic) is temporal in its subliminal affect. If the "sonic environment" is extended to so-called Hertzean waves as well, electromagnetism turns out as sublime temporality in all ways.

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91 Erik Davis, Acoustic Cyberspace. Talk delivered at the Xchange conference, Riga, November 1997; *online* http://www.techngnosis.com/aco. Published in: Rasa A mite / Raitis A mits (eds.), Acoustic Space - net. audio issue, Riga (E-LAB) 1998

92 Marshall McLuhan, Counterblast. 1954 Edition, published by transmediale.11 Berlin (in cooperation with Gingko Press) in 2011

93 Davis 1997

94 Davis 1997

The chrono-poetical specificity of such sonicistic articulation can not be captured and subsumed by the logocentrism of traditional narrative historiography. "Acoustic space", as emphasised by Marshall McLuhan, is of a different temporal nature: not linear, but synchronous or reverberating.[95] McLuhan once called it "echo land" - which brings us back to signal delay time and micro-temporal folding.

Acoustic echo implies delay, the very temporality induced by the medium as channel of signal transfer which once led Aristotle in his treatise *Peri psyches* to deal (media-)philosophically with the "Inbetween" (*to metaxy*) - no neo-logism as a term by Aristotle, rather a graphical neo-graphism by writing the adverb with a capital letter, thus turning it into a noun which (after its translation by medieval scholars) turned into the well-known *medium*.

"PHOTOGRAPHY was the mechanization of the perspective painting and of the arrested eye", whereas "Telephone, gramophone, and RADIO are the mechanization of post-literate acoustic space"[96]. Such sonic space is understood here as the epistemological existence of sound.

Notwithstanding his confusing electricity and electronics, McLuhan thereby made a crucial discovery about the intrinsically "acoustic" structure of electronic mediascapes. In a letter to P. F. Strawson, author of *Individuals. An Essay in Descriptive Metaphysics* (1959), McLuhan quotes from that work: "Sounds, of course, have temporal relations to each other ... but they have no intrinsic spatial characters."[97]

The immediacy of electricity has been valued essential by McLuhan as the definite difference to the Gutenberg world of scriptural and printed information: "Visual man is the most extreme case of abstractionism because has has separated his visual faculty from the other senses <...>. <...> today it is threatened, not by anly single factors such as television or radio, but by the electric speed of information movement in general. Electric speed is approximately the speed of light, and this consitutes an information environment that has basically an acoustic structure."[98]

At the speed of light, information is simultaneous from all directions and this is the structure of the act of *hearing*, i. e. the *message* or effect of electric information is acoustic - even when it is perceived as an electronic image (as defined by the video artist Bill Viola in his essay "The Sound of One Line Scanning"[99]).

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95 Marshall McLuhan / Bruce Powers, The Global Village. Transformations in World Life and Media in the 21st Century, Oxford et al. (Oxford University Press) 1989

96 McLuhan, "Five Sovereign Fingers Taxed the Breath" (1954)

97 Dated April 17, 1969. Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford University Press) 1987, 367

98 Marshall McLuhan, letter to Barbara Ward, 9 February, 1973, published in: McLuhan 1987: 466

99 Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (eds.), Sound by Artists, Toronto / Banff (Art

Very media-archaeologically, McLuhan's identification of the essence of electronic media as "acoustic structure" evidently refers to an epistemological ground, not to the acoustic figure (what ears can hear). This ground-breaking took place with the collapse of Euclidic space into Riemann spaces and culminates around 1900 with quantum physical notions (the para-sonic wave/particle dualism, up to the "superstring" theory of today) on the one side, and Henri Bergson's dynamic idea of matter as image in the sense of vibrating waves and frequencies.[100] McLuhan's "acoustic space" is oscillating time and implicitely re-turns in Gilles Deleuze's "interval" philosophy. Less philosophically, it actually happens within algo-rhythmic media.

In a media-archaeological sense, the message of the sonic is not limited to the audible at all, but a mode of revealing modalities of temporal processuality - which requires epistemological auscultation.

If phenomenology is not reduced to human sensation, perception and mind, it extends to a kind of phenomenology *of* and *by* the machine as made possible by signal sensors. It is the "sample&hold" mechanism which not simply translates but even transsubstantiates (to borrow a term from Catholic religous liturgy) the analog physical world into digital computability.

It is not just a further variance in the long history of philosophy of time but, in identifying concrete techno-logical scenarios that media archaeology analyses new "shapes of time" (George Kubler) - by reading circuit diagrams instead of knowledge historiography only. The sample-and-hold mechanism performs *the ephemeral archive* - with its records being "stored" only for a fraction of a millisecond. Condensers as among the smallest electro-physical storage elements, combined with transistors, function as micro-archives here. The electronic bit - other than most people think it - is a temporal being in such electronic circuits, not punctual, but a suspended instant of time (as voltage)

The media-archaeological approach still shares a core cybernetic assumption (cybernetics is not historicized here as a chapter in the history of knowledge, but still burns in the hearts of media archaeologits): From the *coupling* of humans to techno(chrono)logical beings (artefacts), a specific experience of time results.

By elaborate chrono-techniques, the question of "temporality" is de-coupled from history as a specific concept of narratively organizing temporal sequences. Once chrono-analysis is suspended from the historical discourse, a more radical challenge arises: Is it possible to deal with micro-temporealities without mentioning the transcendent signifier "time" at all - in favour of a multitude of descriptive terms, a "field"? "Time - today <...> - seems to reveal a new structure and to unfold in a rhythm that is different from the 'historical' time that governed the nineteenth- and the early-twentieth centuries. In this new chronotope - for which no name exits yezt, even though we live within its

Metropole & Walter Phillips Gallery), 1990, 39–54
100 Henri Bergson, Matter and Memory, London (George Allen & Unwin) 1950, 276

forms - agency, certainty, and the historical progress <...> have faded into distant memory."[101]

["Just as linear history begins with writing, it ends with TV"[102], McLuhan radically declared in a post-Hegelian mode. History depended on a cultural technique which is alphabetic, linear writing. The "writing" of images and texts on the cathode ray tube for television and computer monitors is of a different kind. Electronic media, therefore, are not just another variance in the history of technology but establish a new kind of temporal reality which escapes the concept of history.]

In contemporary society where the grand symbolical horizon and panoramic (pan-chronic) bird-eye view of temporal extension (religious eternity, the epoques and philosophy of history) has been condensed into (or even replaced by) ever shrinking temporal intervals and a focus on condensed present, the close analysis of decisive temporal actions reveals the drama of time-critical media.

The public TV channels in Germany legally are obliged to provide the possibility for users of streaming media online access to a selection of broadcasts stored for a week. What techno-cultural timing unfolds is an extended present, differentiated by a *media dramaturgy* of minimal or even micro-times.

"Liquefying" the archive

David Lynch's film *Inland Empire* which begins with the image of a spinning record on a record player. "As the needle drifts across the timeles surface of reified sounds, we are, once again, in the realm of mechanical preproduction and the logic of industrial time."[103]

Henri Bergson's criticized the mechanical (escapement-driven) clock measurement of time as mathematization which is spatialisation instead of temporal duration. Technical juxtapositions, interjections, cuts and ruptures result in the loss of the chronology and directionality of time. "[T]he digital fragmentation of time is terrifyingly opaque and illegible for the human subject."[104] Such a technological sublime leads to a sublime micro-tempor(e)ality.

With the present interpreted as a function of memory operations (both neurologically and digitally), the transformation of the traditional temp*aura*lity of archival storage needs to be observed. From archival space to archival time, the archival "field" gets into focus. Dynamic micro-media memories induce a cultural shift of emphasis from permanent storage to restless transfer. With the

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101 Hans Ulrich Gumbrecht, After 1945. Latency as Origin of the Present, Stanford, Cal. (Stanford University Press), 38

102 Marshall McLuhan, Counterblast, New York (Harcourt, Brace & World) 1969, 122, as quoted in Bexte 2008: 332

103 Zoltán Glück, After Midnight, or: The Digital Logic of Time Fragmentation in Inland Empire, in: Munitionsfabrik 19 (2008), HfG Karlsruhe, 8-11

104 Glück 2008: 9

aesthetics of re:load, the affinity between the archival operation and cybernetics turns out, resulting in feedback memory and timeshifting. Once these transformations have been analyzed, the topic "suspended memory *versus* total recall" results in a plea for the *secret archive* again.

There are good reasons for questioning the static concept of an "archive" as appropriate term for digital record structures since as a metaphor it is increasingly becoming a hindrance for the analysis of dynamic data storage and circulation. The computer hard disc *moves* stored data in post-structural ways, just like the gramophone record and the magnetic tape did with recorded electronic signals (sound and / or video) before.[105]

Not yet memory? Focus on storage tempor(e)alities

The volativity of data stored in SRAM or DRAM makes all the media-epistemic difference.

According to Husserl, time is a stream of experiences with an infinite chain of *now*-points which are temporal impressions, each of them embedded in a time-sphere of retention (a now-point just passed) and a protention - "an expectation of a now-point which is still in the future but which becomes a now-point in the present"[106]. This rather time-critically counts for acoustic (the mechanical vibrational touch) and haptic sensation especially.

There is micro-memory involved in the sonic perception of presence already; the present is by no means experienced as punctual "now". On the micro-acoustic level this re- and protention has been discussed to explain melody experience by Edmund Husserl[107] and Henri Bergson and fits into what neuro-science calles the time-window of "presence" as perceived within humans: about three seconds of duration.

Micro-archiving the present: intermediary storage, delay lines

Electro-mechanic transmission of photographic images *via* telegraph cables in 19th century was performed via intermediary storage, the "digital" data carrier of punched cards. Even if at first glance, rather complicated, it relieved

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105 On the archive becoming *processual* in digital algorithms, in accordance with Alfred North Whitehead's philosophy of the dynamic event (*Process and Reality*, New York 1929), see Barker 2012
106 As paraphrased by K. R. Eissler, The Psychiastrist and the Dying Patient, New York (Intenrational University Pres) 1955, 272, quoted here after Hartocollis 1983: 4
107 "Jeder Ton hat selbst eine zeitliche Extension, beim Anschlagen höre ich ihn als jetzt, beim Forttönen hat er aber ein bereits neues Jetzt, und das jeweils vorausgehende wandelet sich in ein Vergangen": Edmund Husserl, Vorlesungen zur Phänomenologie des inneren Zeitbewußtseins (ed. Martin Heidegger [*1928], 2nd ed. Tübingen (Niemeyer) 1980, 324

communication engineering from the delicate time-critical synchronisation problem between sender and receiver.[108]

"In the convergence between a repetition and a renewal lies the tendency to archive while bringing forward: past and present instantly simultaneous in the fragmented image. While it loops the past, the digital creates an image of an archival strategy where time passed becomes constantly accessible for the future. [...] reality's duration seems to have become a continuous stream of information potentially open for another time."[109]

Between the archive and the anarchive there is temporary storage. Proper archives essentially aim towards long-term, if not even the unlimited preservation of their documents and today`s media archivists grapple desperately with the problems of technological obsolescence; the temporalisation of archives therefore is an anarchival element in the economy of cultural tradition. New concepts like *The Archive in Motion* (Rossaak 2010) and `temporary archives` are symptoms of this temporalisation of the archive. The immediatenesss of the retrieval of immense volumes of data trough online databases contends with an increasingly short-term maximum usability period, which compemporary culture knowingly accepts. Yet this temporalisation of the symbolic order is predetermined at the operative level of the present itself, namely in the practice of signal and data transmission. Delay lines served the micro-synchronisation of PAL colour television signals as well as the shortterm maintenance of data words in the first electronic computers. It belongs to the nature of so-called new media that they compute by shifting voltage levels interpreted as binary states, constantly accumulating interim values and then deleting them again. The mathamatisation of technical communication by Shannon results in a transmission channel which consistes of discrete temporary storage – an unexpected return of the familiar archival or yet chritically radicalised. The vocabulary of classic archivology fails when faced with such micro-temporal modes of technological action.[110]

"Time of non-reality": *Totzeit*, negative time

Not only do electronic systems tend from perceptible timing operations to subliminal micro-temporal operations (like the in- or rather de-creasing clocking and cycling units in digital computing); a new quality emerges with "binary" information theory: Norbert Wiener's notion of "time of non-reality" which is negative time which does not "count" in binary counting (computing) - real switching moments (*hysteresis*).

108 See Christian Kassung / Franz Pichler, Die Übertragung von Bildern in die Ferne, in: Albert Kümmel-Schnur / Christian Kassung (eds.), Bildtelegraphie. Eine Mediengeschichte in Patenten (1840–1930), Bielefeld (transcript) 2012, 101–121 (110)

109 Markos Hadjioannou, From Light to Byte. Toward an Ethics of Digital Cinema, Minneapolis (Univ. of Minnesota Pr.) 2012, 174

110 See W. E., entry "Zwischenspeicher / Temporary Storage", in: AnArchive(s). Eine minimale Enzyklopädie zur Archäologie und Variantologie der Künste und Medien, ed. Claudia Giannetti, copy-edited by Eckhard Fürlus, Oldenburg (Edith-Russ-Haus für Medienkunst) 2014, 175 f.

There are in fact different classes of the temporal *inbetween*: the Dirac-impulse (the momentary interruption - approaching the ideal time-criticality of the "real") and the temporal moment evolving inbetween switching or flipping binary alternate states. Such a "time of non-reality" (Norbert Wiener)[111] only counts when the speed of calculation approaches the real-time window of presence. For re-presencing the past, an empty signifier is required. But how the represent a void without turning it immediately, and by the very process of signification, into a presentation, i. e. a mark of presence? Mathematically, the cipher (literally *zero*) is to fulfill this function; on the typewriter keyboard, it is the key for *blanc* which performs this (which, in digital terms, is nothing but a – positive – bit as well, indifferent to other ciphers or letters or ASCII signs). Maybe the only way out is to quit the semiotic realm, not musing about signs any more, but reconsidering signs as signals, i. e. as very physical impulses – the very flow and energy of the Internet (as) information. Neither the local inbetween - the *spatium* - nor the arithmetic symbol "zero" is simply nothing; suspension (German / Hegelian "Aufhebung") is the temporal correlate to these terms.

"Less than no time": Telegraphy and the undertunneling of the transmission channel

Case Mai 15th, 2014: Just having had responded to an electronic mail which stayed resident in my computer mail box for a while of 24 hours, sending it off, the addressee unexpectedly turns up at my door. Even before greeting, a ping noise out of his/her pocket indicated that the mobile phone has just received my answer, resulting in an irritating moment of non-reality, under-tunneling the spatio-temporal channel.

The essence of the temporal economy of tele-communication is capitalist chrono-logics, as remarked by Karl Marx in 1857: "[...] while capital must on one side strive to tear down every spatial barrier to intercourse, i. e. to exchange, and conquer the whole earth for its market, it strives on the other side to annihilate this space with time, e. e. to reduce to a minimum the time spent in motion from one place to another"[112] - as already remarked by Heinrich Heine, in his 1844 comment on the opening of a new railway line between Rouen - Paris, "killing space by time".[113] But the transformation into a different kind of temporal suspense of such shrinking delay intervals (in German literally

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111 See Claus Pias, Time of Non-Reality. Miszellen zum Thema Zeit und Auflösung, in: Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 267-279
112 Karl Marx, Grundrisse. Foundations of the Critique of Political Economy (Rough Draft), Harmondsworth (Penguin) 1973, 538 f.
113 See Roland Wenzelhuemer, Globalization, Communication and the Concept of Space in Global History, in: Historical Social Research, vol. 35, No. 1 (2010), 19-47; furthermore Jeremy Stein, Reflections on Time. Time-Space Compression and Technology in the Nineteenth Century, in: TimeSpace. Geographies of Temporality, ed. by Jon May / Nigel Thrift, London / New York (Routledge) 2001, 106-119

Nachträglichkeit) known from postal communication, in times of mathematically informed, is binarily coded data transfer.[114]

The psycho-physiological discovery of the "tenth of a second" as perceptual unit of presence coincided not only with the chronophotographic analysis of motion and the cinematographic frequency of image projection to produce the impression of a continuous movement, but as well with the "dot" and "dash" rhythm of telegraphic communication in late nineteenth century. In fact, their measuring and transmission instruments were cooriginary. Commenting on "modern communication", Thomas Edinson's chief laboratory engineer remarked: "We all live on a tenth of a second world."[115]

This counts for the recursion of telegraphic (that is: symbolically discrete) signal transmission in digital broadcasting as well: "[...] new media via cables or satellite reconstruct media temporal configurations by the acceleration and compression of time."[116] This happens within such signal transfer technologies itself: audio and video compression is a core operation for digital signal processing in streaming media. The Internet provides for (almost) immediate electronic copies of binary values stored in central servers - rather topological than transmissional (in the traditional signal broadcasting sense). Nowadays, CCTV surveillance systems record and store video images to a digital video recorder or (in the case of IP cameras) directly to a server. The retention period of the images produced by CCTV systems (subject to compression ratios and images stored per second) is delayed present in the sense of closed-circuit contemporaneity. "Recordings may be retained for a preset amount of time and then automatically archived, overwritten or deleted, the period being determined by the organisation that generated them."[117]

The micro-temporal *camouflage*: High Frequency Trading

Within virtual data event-fields like the digital Stock Exchange, time-critial temporalities become econimical tempo*realties*. High frequency trading operates with time-"hiding" purposes which had been tested in perceptual experiments in the 1960s: smuggling ultra-short moments of Coca Cola advertising into a regular TV movie, not consciously noticed by the viewer). This brings us back to the cinematographic affect.

A certain *irritation* of presence by the technical manipulatiuon of optical human perception of movement is based, among other criteria, on the physiological phenomenon of *irridation*.[118] This refers to the core procedure of kine-

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114 See Siegert 1993

115 A. E. Kenelly, The Metric System of Weights and Measures, in: Scientific Monthly 23, no. 6 (1926), 551 [quoted here after: Jimena Canales, A Tenth of a Second. A History, Chicago / London (Univ. of Chicago Pr.) 2009, 5

116 Mira Moshe, Media Time Squeezing: The Privatization of the Media Time Sphere, in: Television & New Media 13(1), 2012, 68-86 (73)

117 https://en.wikipedia.org/wiki/Closed-circuit_television; accessed December 12, 2016

mechanics - not in its sense of creating an illusion of figurative movement, but as sensational physiology.

In the conventional view, for understanding economic and financial markets, long-term trends (diagrammatic time lines) have to be examined. Now that such events happen on the scale of seconds and time-fractions below, analytis has to approach such signals in terms of communication engineering and mathematical stochastics *like* (or even *as*) noise, that is: statistically insignificant. In the runup to the 2008-2009 financial crisis, a concentration of miniature flash crashes occurred in banking stocks: "[I]t suggests a link between what goes on at a sub-second level and what happens on the scale of months. At that point it started to look like an ecological system. Because [...] you have predators of all sizes [...]. The algorithms are all looking for and picking up some kind of weakness in those particular bank stocks [...]" - not actually causing the crash, "but they were like sensors of the impending bigger weakness".[119]

Such time-critical algorithms are time-beasts. The focus of Delta-*t* analysis shifts from macro-temporal economical cycles to micro-temporal intervals.

Interplay: Gaming with the Pin Ball machine and time of the tape: spools, loops

The human hand is time-critically coupled in the cybernetic sense in the case of the Pin Ball machine, as described in a typescript entitled "Flipper" by Friedrich Kittler from the late 1960s or early 70s which immediately anticipates the first generation of computer games.[120]

If the human is defined by his gaming instinct, he becomes inhuman once his partner is an automaton. This counts for the temporal aspect of gaming as well.[121] The human pinball player with his hand(s) as interface to the automaton has to critically adopt to the electric tempor(e)ality of the machine.

When discretely (not analog / diagramatically) calculating either in his mind on quare paper with a pencil and erasing head, man is in (Turing-)Machine state.

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118 See further Reiner Matzker, Das Medium der Phänomenalität. Wahrnehmungs- und erkenntnistheoretische Aspekte der Medientheorie und Filmgeschichte, Munich (Fink) 1993

119 Andrew Smith, Fast money: the battle against the high frequency traders, in The Guardian *online*, 7th June, 2014; http://www.theguardian.com/business/2014/jun/07/inside-murky-world-high-frequency-trading (accessed 15th July, 2014)

120 In: Friedrich Kittler, Baggersee. Frühe Schriften aus dem Nachlass, hg. v. Tania Hron / Sandrina Khaled, Paderborn (Fink) 2015, 58 f.

121 "Wenn der Mensch nur dort ganz Mensch ist, wo er spielt, so wird auch er, wenn sein Mitspieler Automat ist, zum Unmenschen." The typescript is kept in the "Miscellanea Curiosa" of the Kittler papers at the German Literary Archive, Marbach.

The challenge of anti-aircraft prediction in World War II from the point of view of the artillery, as confronted by Norbert Wiener - gave rise to *Cybernetics* itself (Wiener 1948, Introduction) - and by Claude Shannon in a different approach separating the physical laws of the machine (airplane) from the idiosyncratic (counter-)reactions of the human pilot.

The human "Flipper" game player with his hand(s) as interface to the automaton has to adopt to the tempor(e)ality of the machine; Kittler inserts a Latin quote. The equivalent to tactics in the temporal field of such cybernetic human-machine couplings is time-criticality.

Cybernetics has replaced the notion of the present moment as *stasis* by the insight into "Circular Causal and Feedback Mechanisms in Biological and Social Systems"[122].

In Bergsonean philosphy of time, time is "a tape running between two spools"[123] - opposed to the micro-temporal "samples" in William Burrough's magnetophonic cut-ups.

[Media-archeaological *musing* in the presence of such a magnetic tape spool is in a situation like prince Hamlet, equipped with his father's scull in Shakespleare's drama. The artefact is present-at-hand *versus* present-to-hand in Martin Heidegger's understanding: being re-played on a tape recording machine.]

On the even more subliminal level of temporal perception, "different stimuli which are processed within a *temporal window* of approximately 30 ms are treated as *co-temporal*, i. e., a temporal relationship with respect to the before-after dimension cannot be established for such stimuli. Information gathered within a temporal window of 30 ms is treated as *a-temporal*, i. e., there is no temporal contuity defined and definable for stimuli that follow each other within such intervals."[124] There is a tempor(e)al sublimity of "digital media", underscoring human perception in favor of an apparent continuity of time, but still being *sublimely* time-discrete.

Micro-archiving presence from analog to digital technologies: functional sounding

122 The original title of the so-called Macy-Conferences in New York, ed. by Heinz von Foerster 1949, and subsequently by v. Foerster / Mead / Teuber 1950, 1951, 1953, 1955

123 See Barker 2012; 59 f., referring to: Henri Bergson, The Creative Mind, N. Y. 1934/1992, 164

124 Ernst Pöppel, Reconstruction of Subjective Time on the Basis of Hierarchivally Organized Processing Systems. Lecture given at the conference: Time, Temporality and Now, Max-Planck-Gesellschaft, Schloß Ringsberg (at Tegernsee), February 1996, quoted here after Klose 2002: 359

As long as it is not supplemented (or merged) with an optical perception, the perception of a bodyless voice from the past from a recording leads to an essential lack of the sense of origin.

The most common notion of "historical" time is based on an external observation, drawing of a distinction (in Spencer-Brown's terms[125]) between past and the present. In digital computing, this distinction has collapsed technologically into the most minute, i. e. binary micro-temporal différance (in Jacques Derrida's neo-graphism), as has been applied e. g. in the ENIAC computer: "[W]e feel strongly in favor of the binary system for our [sc. "memory"] devices. Our fundamental unit of memory is naturally adapted to the binary system since we do not attempt to measure gradations of charge at a particular point in the Selectron [sc. cathode ray tube] but are content to distinguish two states"[126] - which makes all the difference to analog computing.

The electro-magnet relay and later the flip-flop materially provided for such a truly binary device. "On magnetic wires or tapes and in acoustic delay line memories one is also content to recognize the presence or absence of a pulse of (if a carrier frequenfy is used) of a pulse train."[127] This leads to the time-functional use of sound which is *sonicity*.

Technical recording of sound itself is a process of storage. "The breaking of the time constraint has profoundly changed the nature of acoustic communication."[128] The temporality (and volatile being-to-death) of sonic articulation which hitherto could only by recorded symbolically by mnemonic notation is transformed into space and visualization by the very act of recording, making it available for analysis "outside of time" <ibid.>. The temporal essence of sound is thereby turned into a reified, objectified time object, from evanescence to the literally ob-scene.

The traditional sound record - like the textual record - can be included within an institutional archival frame. With digital sound, though. literally every bit of sonic articulation becomes part of a generalized "archival presence", since a) every digital signal processing involves ultra-short quasi-archival intermediary storage and b) every sound "bit" becomes numerically addressable and thereby accessible to mathemtical / algorithmic manipulation. The archival frame is deconstructed and re-turns from within the digital archival records themselves. From analog to digital "archiving" of sonic presence, "the manner of storage determines the kind of control that can be exercised over it" - from manipulation to distortion.[129] At the same time, the analog-to-digital conversion results in a transsubstantiation of the audio signal: from the primary physical

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125 George Spencer-Brown, Laws of Form, Portland, Ore. 1994
126 Section 5.2., in: Arthur W. Burks / Herman H. Goldstine / John von Neumann, Preliminary Discussion of the Logical Design of an Electronic Computing Instrument, in: John von Neumann, Collected Works, vol. 5, ed. by A. H. Taub, Oxford (Pergamon Press) 1961, 34-79
127 Burks et al. 1961: 227
128 Barry Truax, Acoustic Communication, Norwood, N. J. (Ablex) 1984, 117
129 Truax 1984: 119

event to information which is essentially neither energy nor matter. Thereby the signal loses its time-indexical trace[130]; transitive wave forms become numerical, geometricised time. Electro-magnetic sound transduction must therefore to be set into quotation marks: "[...] the digital 'transduction' process includes the digitalization of the analog signal by the ADC, its <micro->storage and / or manipulation in binary number format, and its reconstruction as an anlog signal by the DAC"[131] - which is the conversion of an electronic embodiment of a number representation stored in the computer memory to discrete voltage steps at fixed time intervals (Dt). The physically continuous original waves are thus transformed into quare waves; in fact every binary computational act is an abrupt form of oscillation between zero and one in a time-sequential form. Only by smoothing the square wave by filters the wave becomes continuous again.

A kind of micro-archiving of presence is conceptually and technologically implied in the real-time processing of signals, since as a digital time-discrete sampling and quantizing of moments from the present signal (punctualising the continuous signal event) it requires intermediary short-time storage of data. The concept of real-time and "interrupt" for user input in computing dislocates the metaphysics of pure presence to micro-deferred presence.

Instant archivization of the present reveals itself in newsradio channels with its frequent errors in (re-)play. What appears like actual news broadcast, by mistake (the new editor pushes the wrong button on his digital control panel) an event just reported is repeated again. It is a shock for the "presence" instinct authenticity contract between listener and radio station when it becomes apparent that there is not live transmission any more, but digitally stored ("sampled" on the micro- and meso-level) sound files - a presence which is "archived" already. The present event and storage merge into one with the increasing digital, i. e.: archiving recording of present spaces. The presence of space itself is being transformed into time-coded snapshots by increasing instant photography (I-pad) which step by step ("one bit at a time") *samples* presence (sampling in both technological and meso-temporal meaning). Space itself will be re-windable.[132]

Media-induced shock more general

The traumatic implosion of an electronic image (as in the case of the last transmission a public speech by Ceaucescu in Rumania December 1989[133]) is of a different kind than the disruption of a celluloid film. Recently, the break-down of Greek state radio and TV broadcasting by a sudden government decision to close down the stations for budget shortages resulted in a technologically

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130 See Laura Marks 2002
131 Truax 1984: 139
132 See Alexander Galloway / Eugene Thacker, The Exploit. A Theory of Networks, Minneapolis 2007, 132. See as well the notion of *tx-transform* as technology of time axis manipulation and as title of a short film produced by Martin Reinhart with Virgil Widrich (35 mm, Austria 1998)
133 See Peter Weibel, xxx; Harun Farocki / Andrej Unija, xxx

induced shock: "It is quite an experience as Silence and Black reigns on public Greek media. In TV it was much more dramatic because the closure had already been announced and there were theatrical countdown moments when the frequency was shut down."[134] Indeed, the visual shock of abruptly finishing broadcast is of a different kind than the acoustic experience.

"Shock" with Benjamin

Human perception is shaped by the variant media conditions. In a way close to what Marshall McLuhan later termed "the medium is the message", Walter Benjamin interprets film not in its content but rather as a setting just like a physiological experimental laboratory.[135] The dramaturgy of "choque" accommodates the audience on the perceptual level to the speed of modernity and time-critical moments. What escapes the imaginary (the cinematographic screen and its illusion of flowing movement), is subliminally perceived as a fragmented series of 24 frames per second, involving a permanent affective / cognitive dissonance on the non-discursive level already..

"Where Hegel considers the process of digestive remembrance to be the interiorization of the past (*Er-Innerung*), Benjamin associates involuntary memory with a contrary exteriorization of the self that explodes the confines of its private interiority. The `disorder' of this anarchic *Bildraum* (which, if spatial, is anything but homogeneous) dislocates the orderly `gallery of images'."[136]

Walter Benjamin coined the term "physische Chokwirkung" for the cinematographical image.[137] Different from the photographic *punctum* (Barthes), the traumatic moment in the filmic image is its temporal movement- thus closer to the phonographic voice. Whereas an image can be motionless endurance, a recorded sound can not but dynamically unfold - between the temporal now ("the present") and auratic appearance ("presence" and "re-presencing").

In his notorious essay on "The Work of Art in the Age of Reproduction" (1936) Walter Benjamin identifies a loss of aesthetic "aura" which is bound to tradition and the uniqueness of the work of art in space and time by means of technical reproduction (mainly photography, but as well phonography, influential up to Baudrillard's notion of simulation. Furthermore, Benjamin sees human perception shaped by the variant historic media conditions. In a way close to what Marshall McLuhan later termed "the medium is the message" he interprets film not in its content but rather as a setting just like a physiological experimental laboratory, when stating that the audience is subjected by the

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134 E-mail communicaiton by Konstantinos Vassiliou on August 13, 2013

135 "Das Publikum fühlt sich in den Darsteller nur ein, indem es sich in den Apparat einfühlt. Es übernimmt also dessen Haltung: es testet." Walter Benjamin, Das Kunstwerk im Zeitalter seiner technische Reproduzierbarkeit [*1936], Frankfurt/M. (Suhrkamp) 1963, 26

136 Irving Wohlfarth, "Benjamin", xxx, 189

137 Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit, in: same author, Illumination, ed. S. Unseld, Frankfurt/M. (Suhrkamp) 1969, 148-184 (172)

apparatus into a psycho-laboratory *test* situation.[138] The dramaturgy of "choque" accommodates the audience on the perceptual level to the speed of modernity and time-critical moments, as expressed in Ernst Jünger's writings on photography.

The anachronistic momentum of technological recording

Woody Allen's film *Zeelig* operates with digitally interpolated past as fictitious testimony. Unlike the Barthean "punctum" in photography, the anachronism is not imbeeded in the recording itself any more.

The time-critical moments of *mémoire involontaire* in Marcel Proust's *A la recherche du temps perdu* which look contingent can be neuro- and media-archaeologically "grounded". The reanimation of phonographically un-dead sound recordings falls short from the theological notion of redemption; so let us not be trapped to follow a hidden "messianic" eschatology masked by so-called media archaeology. With any re-play of an old phonographic recording of Caruso's voice, history-defying short circuits presuppose that the mechanical and electromagnetic rules known to the designers of sound recording devices are still in operation today. Indeed, the phonographic record allows for time axis manipulation against the physical and cognitive law of the irreversibility of history. "New media, as vehicles that carry our senses and bodies across the space-time continuum, introduce to us old modes of experience [...]. Media thus bear the messianic power, in Benjamin's special sense of that word, to forever alter the past."[139]

The Edison phonograph did not arise from desire for a memory medium. In fact it rather unintentionally resulted from Edison's experiments in speeding up transmission of telegraphic signals, recording the Morse code dots and dashes on an intermediary storage device (the embossy telegraph with rotating discs) for accellerated transmission: "[...] to make a repeater that would store words without the labor of the human hand [...]"[140] - just like the draughtsman Henry Fox Talbot developed photography from his wish for images from nature to be liberated from the inaccuracies of his painterly hand.

If for this reanimation of dead sounds and images the word "redemption" might be applied, this is not simply a reference to Walter Benjamin's "messianic" historical materialism; we might phrase it rather the other way round: Benjamin's phrasing is now itself redeemed by technical media of suspended time.

Signal "immediacy": dissimulated presence

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138 "Das Publikum fühlt sich in den Darsteller nur ein, indem es sich in den Apparat einfühlt. Es übernimmt also dessen Haltung: es testet." Benjamin 1936 / 1963: 26
139 John Durham Peters, Helmholtz, Edison, and Sound History, in: Lauren Rabinovitz / Abraham Geil (eds.), Memory Bytes. History, Technology, and Digital Culture, Durham / London (Duke University Press) 2004, 177-198 (195)
140 Peters 2004: 188

The term "presence" expresses the subjective perception of non-mediation in media participation[141], well known from traditional rhetoric as the figure of hiding the awareness of artificial speech configuration *dissimulatio artis*. When a voice from phonographic record is being re-played, both the technicity of the apparatus and the historicity of the actual recording are being forgotten in favour of the physiological a/effect of presence. Bolter & Grusin, developing on McLuhan's *Understanding Media*, describe such *immediacy* for the realm of visual representation "whose goal is to make the viewer forget the presence of the medium (canvas, photographic film, cinema) and believe that he is in presence of the objects of representation"[142] - whereas *hypermediacy* actually emphasizes the presence of the medium and does not dissimulate it in favour of the impression of using a previous (familiar) one - just like modernist painting, according to Clement Greenberg, is defined by making the carrier medium itself the aesthetic message.[143]

"POSTING" DIGITAL PRESENCE: A MICRO-TEMPORAL REGIME

"Post-digital" media culture? Sustaining a critical philosophy of algorithmically driven technologies

Expressions like "from analogue to post-digital", like any "postism", already suggests a *temporal* vector, a linear, almost teleological evolution. In a genuinely media-archaeological critique of such chrono-logic historicism, computer-based culture gets progressively used to non-linear figures of tempor(e)ality, as known from computer programming itself: the "GO TO" jump order in algorithmic source code, and other figures likes iteration, loop, and recursion.

It is this "post-digital" tempor(e)ality which deserves close analysis. The micro-temporal features of the "post-digital" condition result in almost imperceptible, fundamental irritations of the sense of the present. The technical core of such operations of sampling the visual present is the sample-and-hold mechanism for converting analog signals into digital bits. This invites for a revision of the perceptual impression of visual movement from chrono-photographic reproduction. Human perception of the "present" is affected by sublime micro-technological zones of indeterminacy between the analog and the digital, especially in its sonic emanations.

The historicism suggested by the adverbial trajectory *from* analogue *to* the post-digital is seductive. In many media-archaeological respects, the digital

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141 As defined by Wulf Kansteiner in his lecture on "Interacticity, Immersion, and Historical Consciousness" at the Glasgow Memory Group symposium *Digital/Social Media and Memory*, April 17th, 2013
142 Jay David Bolter / Richard Grusin, `Remediation. Understanding New Media, Cambridge, Mass. / London (MIT Press) 1999` 2000, 272 f.
143 Clement Greenberg, Toward a Newer Laokoon [1940], in: idem, The Collected Essays and Criticism, vol. 1: Perceptions and Judgments, 1939–1944, Chicago / London 1986, 23-38

image has preceded the analogue one, like Alexander Bain's telegraphic image transfer already in early 19th century.

The "Editorial" of the Post-digital Research journal APRJA provides a working definition of the *post-digital*: "Post-digital, once understood as a critical reflection of 'digital' aesthetic immaterialism, now describes the messy and paradoxical condition of art and media after digital technology revolutions. 'Post-digital' neither recognizes the distinction between 'old' and 'new' media, nor ideological affirmation of the one or the other. It merges 'old' and 'new', often applying network cultural experimentation to analog technologies which it re-investigates and re-uses. It tends to focus on the experimential rather than the conceptual"[144] - which nowadays results in an explosion of emergent "labs" in digital humanities.

The current discussions on the "post-digital" remind of the former debates on the "post-modern". Against the post-isms, Jean-François Lyotard, in *The Postmodern Condition*, rather defines the "post" as enhancement, not as "beyond". If in that sense "postmodernity" did not represent a new age, but rather repeated essential features of modernity[145], let us rather re-think the "digital" than dismiss it too early. It takes time to confront the challenge of the digital epistemologically. The fact that in unbiquitous computing the digital seems to have become part of everyday culture - just like listening to music from an MP3-Player introduced complex compression algorithms into popular culture - does not mean that contemporary culture has already digested the shock of digital electronics invading the analog world.

There is a "law of media" (Marshall McLuhan) which says that when the experimental initial era of a "new medium" (where it is still consciously media-archaeologically experienced and reflected by the users) is being transformed into a mass medium, no the techno-logical message of the medium recedes behind its semantic and cultural "content". After "the digital" has been culturally ingested and become an everyday commodity with ubiquitous computing, we are not yet "post-digital" but - in analogy to traditional radio and television - we are in a "mass-digital media" age. The digital, though, still needs to be media-theoretically and epistemologically to be "ingested" (Freudean *Durcharbeiten*) - which requires hard-edged techno-mathematical analysis of processual algorithms (radical media archaeology). The focus of my argument is therefore *not* on the term "post-digital" how it is used in the discourse of digital artistic practice which serves as a kind of tranquillizer for humanities: "It points to an attitude that is more concerned with being human, than with being digital."[146]

McLuhan's posthumously published manuscripts on media time under the title *Laws of Media* are a kind of a media theoretical equivalent to Hayden White's seminal *Metahistory*. According to McLuhan, there is a chrono-logical (not

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144 Issue 3.1 (2014) on *Postdigital Research*; see www.aprja.net

145 Anne Elisabeth Sejten, Exhibiting and Thinking: An Anamnesis of the Postmodern, in: Yuk Hui / Andreas Broeckmann (eds.), 30 Years after Les Immatériaux. Art, Science, Theory, Lüneburg (meson press) 2015, 159-178 (168)

146 http://en.wikipedia.org/wiki/Postdigital; accessed May 11, 2015

simply annalistic) figure of how technical media unfold in cultural time indeed: First - in its media-archaeological incubation - the new technology (such as cinematography or video, or the phonograph whose material presence receded behind the loud-speaker) itself is subject of attention and avantgardist experimentation; after a time of cultural accommodation it becomes a simple commodity and the focus shifts from the medium's message to ubiquitous content.

Significantly, one of the uses of the term "post-digital" developed in the sonic context. Kim Cascone coined and uses the term in his article "The Aesthetics of Failure: 'Post-digital' Tendencies in Contemporary Computer Music"[147]; this referred to the glitch, to circuit bending, to "media archaeological" research art.

Nicholas Negroponte declared "The digital revolution is over" at MIT Media Lab in 1998.[148] In his version of the "post-digital", Cascone directly referred to Negroponte's manifesto in his analysis that "the revolutionary period of the digital information age has surely passed" <Cascone 2002>. Indeed, when the media-archaeological incubation phase is over (experimenting and experiencing a technological invention), the technical *a priori* becomes a black box in favour of aesthetic interfaces.

But inbetween is techno-locigal formats and "apps". Here not the complex medium apparatus as such is the message like with radio and television before; rather, their specific electronic affordances and software tools themselves have become the *sub-mediatic* message. It is tools such as Max, SMS, AudioSculpt, Pure Data, and other that make possible "post-digital" music" (Cascone) which is characterized by micro-sonic, almost DNA-like operations.

As has been demonstrated by Martin Heidegger with the human use of the hammer as tool already, it is only from the failure (and noise) of a technology that the medium articulates itself.

["[G]litches, bugs, application errors, system crashes, clipping, aliasing, distortion, quantization noise, and even the noise floor of computer sound cards are the raw materials composers seek to incorporate into their music."[149] Jem Finer defined the term *post digital*, in relation to his own artistic work, as "a return to a tactile relationship with ideas and materials informed by over 30 years of working with computers. A practice that seeks to transcend mediation via a screen and locate itself in the physical world, rather than at one stage removed, through digital representation". He first formulated the term in relation to his 1000-year-long musical composition, *Longplayer*[150]. But there is more involved than just a nostalgia for the haptic dimension in analogue media interfaces; this "retro"-mania is rather an epistemological symptom, the

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147See http://subsol.c3.hu/subsol_2/contributors3/casconetext.html (accessed May 12, 2015); originally published in Computer Music Journal 24:4 Winter 2002 (MIT Press)

148Nicholas Negroponte's seminal essay "Beyond Digital, in: Wired 6 (12), 1998; http://www.wired.com/wired/archive/6.12/negroponte.html

149Cascone ibid.

150As quoted in: http://en.wikipedia.org/wiki/Postdigital; accessed May 11, 2015

longing for re-gaining a sense of temporality which has lost in hight-frequency media culture operations.]

In a couple of other new media art works as well, the "post-digital" primarily refers to the re-entry of the physical existence and that into "the abstractness of the digital world"[151]. But then, is it only the hardware-oblivion of most digital media users and theorists which leads to this recent discovery that even the most immaterial and virtual mediascapes radically (that is: on the media-archaeological level) ground in ultimately analog electro-physics. The "bit" has always been (and still is) nothing but an extreme articulation of the continuous - from the conceptual "digital" back to the analogue.

The sublime presence of ubiquitous computing

In his book *The Computer for the 21. Century* (1991), Marc Weiser predicted ubiquitous computing: "Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence."[152] In other words: Digital media transform into a *sublime* presence - sublime in Edmund Burke's and Immanuel Kant's definition of a sensation of something which is there but can not be figuratively imagined by humans.[153]

This reads like a counter-historical recursion of the first "digital" writing system in culture: the vocal alphabet, which in the first generation had been subject of media-critical attention (Platon, *Phaidros*), but then became cultureal everyday practice, so that writing and reading hermeneutically shifted from the awareness of signifiers to a focus on semantic content.

All the more the media-archaeological veto is required, a kind of *katechon* ("beholder") as defined in the 2nd epistle of apostle Paul to the city of Thessalonike: The task is to defer public oblivion of the techno-mathematical conditions for articulations in so-called digital culture.

The re-entry of the "analogue" in the "post-digital"

The discourse of the "post-digital" is useful when it helps to get rid of the simplistic use of the adjective "digital" which is confused with binary computing - whereas "digital" cultural techniques are as old as culture itself (counting with fingers, vocal alphabet, Morse code).

The "digital" has been at work already in alphabetic writing and the cinematographic frame sequence. The "analogue" media came inbetween: photography, phonography, electro-magnetic broadcast media (radio,

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151As quoted in: http://en.wikipedia.org/wiki/Postdigital; accessed May 11, 2015
152http://wiki.daimi.au.dk/pca_files/weiser-orig.pdf, as quoted in: http://de.wikipedia.org, entry "Postdigital", accessed May 11th, 2015
153See Jean-François Lyotard, The Sublime and the Avantgarde, in: xxx

television). With computing, the digital returns; in techno-mathematical terms, the numerical ("digital") signal analysis in the frequency domain is the inverse value ("Kehrwert") of the analogue wave form in the time domain.

Media-temporal loops happen in insular modes, different from media-historical emplotment of technological evolution. The alphabetic code corresponds with telegraphy, against which telephony (analogue signal transmission by electric transduction of the human voice) intervenes. But with "voice over IP", even telephony returns as digital communication.

As a critique of historical dicourse, I have trouble with terms like the "post-digital". Each *postism* affirms the narrative plot that technologies are being invented, they emerge, they florish, they end, to be succeeded by another technical dispositive.

The term "post-digital" is meant to express that media culture has entered a stage where the digital as such is not an object of newness and excitement any more since in everyday life, in academic practice and in media art it has become common to work interactively. I still insist that the digital challenge, even if practically "ingested", has not yet been epistemologically and critically digested and needs ongoing media-archaeological distancing reflection.

We might be "post-digital" in the sense of everyday usage of media, but when we stay aware of NSA data surveillance tools, we certainly still have to critically investigate the algorithmic digitality and tempor(e)ality.

On the phenomenological side, it is true that communication culture has become "post-digital" insofar as computational algorithms embedded in mighty processors have become so efficient that most humans are not even aware of the discreteness of digital events (be it sound, be it vision, be it communicative interaction) unless a momentary breakdown of real-time processing happens - which leads to a common confusion between "live" (as affective experience) and "real-time" (as its technological condition). On the level of physiological perception the "analog days" return - but just as a time-continuous simulacrum, dissimulating its time-discrete and micro-archival nature of intermediary storage. In that sense, the storage-programmable computer (the "von Neumann architecture"), coupled with predictive algorithms (the "future in the past" mode of temporalizing presence), is the technology to be focused.

A core of the operation: The sample-and-hold mechanism

Claude Shannon's canonical sampling-theoreme describes the digital ratio of the "slicing" of a continuous signal flow in order to preserve the signal fidelity intact. The current notion of "streaming" media in online access to audiovisual content metaphorically disguises the discrete nature of signal processing and linear buffering.

In Jim Campbell's media art installation *Church on Fifth Ave* (2001), a matrix of 32 x 24 (768) pixels made out of red LEDs displays a pedestrian and auto traffic scene in New York from an off street perspective. A sheet of diffusing plexiglass is angled in front of the grid. As the pedestrians move from left to right the

figures gradually go from a discrete representation to a continuous one - or metaphorically from a digital representation to an analog one.[154]

Let us understand the message of this installation in the media-epistemological sense. Once being subject to algorithmicized signal processing, any "analogue", apparently continuous representation of an event is irreducibly discrete - which shows up in the very artefacts ("glitches") the "post-digital" aesthetics is so fond of. This is noticable on the margins of the Campbell QuickTime Movie itself. The analogue here becomes a retro-nostalgic re-entry *within* the digital.

Human perception tends to smooth dicrete data into coherent signals anyway, since it functions as a kind of digital-to-analog converter, when confronted with the pixelised image resolution - just like in mechanical cinema frame sequences and analog television scan images already.

Epistemologically, the digital infinitesimally approximates the physical world. But the perfidious power of "the digital" unfolds with Digital Signal Processing, since this allows to simulate the "worldly" analog signal in high *temporal* fidelty - like physical modelling does with instruments in electronic music.

Between the analog and the (post-)digital a techno-mathematical operation reigns. Any periodic wave signal - be it auditory in the time domain or a visual pattern in space - can in reverse, by means of the Fourier Transform, be numerically addressed in the frequency domain and thereby becomes accessible to computing intelligence.

In times of communication technologies which are based on the Sampling Theoreme, the human sense for the difference a natural and an artificial sound or movement fails. Digital computers have become capable to successfully re-the voicing of the analogue world.

Media archaeology locates the scene of the "digital" where it precisely happens. Every digital device, in its physical media-archaeological essense, remains ultimately analogue in the temporal sense. Any switching between two binary states from low voltage "zero" to a higher level "one", however abrupt, is (electro-)physically time-consuming but literally *does not count*; Spencer-Brown's term "drawing a disctinction" is a time-critical act itself. According to Adrian Mackenzie, such "dead-time refers to a spacing or non-identity 'within the presence of the living-present [...]'"[155]. Norbert Wiener once coined this by the enigmatic expression "time of non-reality".[156] This *inbetween* is the

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154 See
http://www.jimcampbell.tv/portfolio/low_resolution_works/fifth_ave nue/church_on_fifth_avenue/
155 Adrian Mackenzie, The Mortality of the Virtual. Real-time, Archive and Dead-time in Information Network, in: Convergence Bd. 3, Heft 2 (1997), 59-71 (67)
156 See Claus Pias,Time of Non-Reality. Miszellen zum Thema Zeit und Auflösung, in: Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 267-279

temporal equivalent the Aristotelean notion of *to metaxy* which became, in Latin scholastic translation, the *medium* of signal transmission.

Luciano Floridi, describing the phenomena of ubiquitous computing and the "Internet of things", sees "[t]he threshold between *here* (*analogue*, *carbon-based*, *off-line*) and *there* (*digital*, *silicon-based*, *online*) <...> fast becoming blurred <...>. The digital is spilling over into the analogue and merging with it."[157] This actually extends to the temporal dimension: "[T]he very distinction between online and offline will disappear."[158] Indeed, Global Positioning Systems calculate a position in space as a triangulation of signal runtime differences - space becomes a function of time-critical communication. "Radio Frequency IDentification (RFID) tags store and remotely retrieve data from an object and give it a unique identity, "like a barcode" <ibid.>. Thereby the material present is coupled to the archive already.

Instant recording: Archiving the present and re-presencing the past

Archiving the present in real time takes place in Web-based formats of radio and video, so-called "streaming" media. The old metaphor for the flux of time dissimulates the radically bit-discrete character of buffering data and the time-consuming complex calculation.

Big data analytics which is conducted at a velocity that is approaching real time already has an immediate effect on our personal environments or decisions being made online, since companies are increasingly demanding instant analysis.[159]

Instant micro-archiving of the present is conceptually and technologically implied in the real-time processing of data, as a digital time-discrete sampling and quantizing of moments from the present signal - a punctualisation and mathematisation of the continuous event. This requires fractions of intermediary short-time storage of data. The concept of real-time communication, time-sharing and "interrupt" for user input in computing dislocates the metaphysics of the pure present to micro-deferred presence.

A whole scale of micro-temporal "archiving presence" thereby unfolds, starting from ultra-short intermediary storage of electronic equivalents to zero and one in registers and flags, up to time axis manipulations after the digital sampling or recorded signals.

The media form of the analog present, for the longest time in 20th century, has been the notorious "live" transmission of signals by electro-magnetic waves. By means of digital sampling, data compression and real-time computation (the "digital" equivalent to "live" transmission), news media manage to achive the "live" effect even under digital conditions - a "post-digital" effect. But in news

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157 Luciano Floridi, Information. A very short introduction, Oxford / New York (Oxford UP) 2010, 16
158 Floridi 2010: 16
159 See BIG DATA: SEIZING OPPORTUNITIES, PRESERVING VALUES, report by the Executive Office of the President, May 1, 2014; URL: xxx

radio channels, glitches frequently betray that the audience is dealing with digital re-play. What appears like actual news broadcast, by mistake (when the news speaker activates the wrong icon on his digital control panel) a message which has just been spoken is repeated again. All of the sudden (and as a shock for the temporal authenticity contract between listener and radio station) it becomes apparent that there is not direct live transmission any more, but digital sound files sampled and stored on the sublime micro-level - a presence which is always "archived" already. The present event and storage merge into one with the temporally augmented digital.

The presence of space itself is being transformed into time-coded snapshots by increasing instant photography (I-pad) which step by step ("one bit at a time" is the rhythm of digital computing) *samples* the present (in its technological and phenomenological sense).[160]

Frequently the present moment has been considered as punctual: between the "not yet" and the "no more". The Aristotelean, that is: numerical time-definition (culminating in Zenon's paradox of capturing the flying arrow at a moment) is discrete, a kind of sampling the present by clocks which Heidegger denounced as even "vulgar" time. Leibniz and Newton develop the appropriate mathematical tool for infinitesimally approaching this volatile moment which thus becomes a chrono-epistemic *momentum*. Just like Henri Bergson already criticized chono-photography's "mathematical" sequencing of pure movement.

The proverbial photographic moment has always been a paradox: from the moment of the photographic click (which in itself, at close reading, is never punctual but a shrinking interval), the present is transformed into endurance. Analog archiving of the present is nowadays being matched by the "thickening of the present moment" in digital systems[161] - a kind of micro-archival bubble.

With its instant digital recording, the present becomes immediately addressable and thus transforms into an implicit, sublime archival structure. By instant digital recording in real time, the present looses its metaphysical uniqueness before it even happens. The present no longer is granted time to take place, and instead is replaced by digital post-presence.

TEMPORALIZING THE PRESENT AND ARCHIVING PRESENCE. The impact of time-critical media technologies

"Sample and Hold": Micro-archiving presence from analog to digital

The media-archaeological spelling of (micro-)tempor(e)alities on the one hand reminds of the Latin notion for *realitas* from *res*, the material artifact. Media time is embodied temporalities. The spelling of tempor(e)ality is further influenced by Alfred North Whitehead's philosophical thoughts as well: his

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160See Alexander Galloway / Eugene Thacker, The Exploit. A Theory of Networks, Minneapolis 2007, 132

161 Timothy Barker, `Time and the Digital. Connecting Technology, Aesthetics, and a process Philosophy of Time, Hannover, New Hampshire (Darmouth College Press)` 2012, 194

dynamic theory of *Process and Reality*. But at the same time, media archaeology is more strictly *grounded* in the technical sense. German "geerdet" (grounded) is an expression from electro-technical engineering, indicating that circuits in hardware have to be connected with the phyiscal "mass". Let us therefore not reduce media phenomenology to human sensation, perception and mind, but extend it to a kind of phenomenology *of* and *by* the machine as made possible by signal sensors. It is the "sample&hold" mechanism which not simply translates but even transsubstantiates (to borrow a term from Catholic religous liturgy) the analog physical world into digital computability.

In reading concrete techno-logical scenarios such as circuit diagrams, media archaeology identifies new "shapes of time" (George Kubler). The sample-and-hold mechanism (before the signal actually gets digitally quantised) performs the *the ephemeral archive* - with its records being "stored" only for a fraction of a millisecond. Condensers figure among the smallest electro-physical storage elements, and combined with transistors they function as micro-memories here. The electronic sound slice is a temporal being in such electronic circuits, not punctual, but a suspended instant of time as voltage.

The observational separation between past and the present has shrinked technologically into the most minute micro-temporal *différance* in digital computing. The fundamental unit of memory, the electro-magnetic relay, for electronic ingineers seemed "naturally adapted to the binary system" since they did not attempt to measure gradations of charge at a particular point but were "content to distinguish two states"[162] - which makes all the difference to the time-functional classical black & white television scan line, and to analog computing. The flip-flop as truly binary device provides for the rhythm. Magnetic wires or tapes or acoustic <!> delay line memories recognized the presence or absence of a pulse or (if a carrier frequency was used) of a pulse train."[163] All of the sudden, beyond the phenomenological notion of the continuum of time (Bergson), computer time sounds different.

The temporalized cyborg, signal time and acoustic media archaeology

The media-archaeological approach shares a core cybernetic assumption - since cybernetics is not historicized here as a chapter in the history of knowledge. From the *coupling* of human beings to techno(chrono)logical (artefacts), a specific experience of time results.

Now, if there is a specific alliance between the micro-patterns and "larger gestalts of auditory temporality[164] on the phenomenological level and the processual being of technical media, their time-critical moments affect the

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162 Section 5.2., in: Arthur W. Burks / Herman H. Goldstine / John von Neumann, Preliminary Discussion of the Logical Design of an Electronic Computing Instrument, in: John von Neumann, Collected Works, vol. 5, ed. by A. H. Taub, Oxford (Pergamon Press) 1961, 34-79; Wiederabdruck in: Swartzlander (Hg.) 1976, 221-xxx (227)
163 Burks et al. 1961 / 1976: 227
164 Don Ihde, Listening and Voice. Phenomenologies of Sound [*1976], Albany, NY (State University of New York) 2007, 87

most frequency-sensitive ("rhythmic") sense organ within the human which is hearing.

This has consequences for re-presencing the technically recorded "audible past" (Jonathan Sterne). If a movie projector is driven manually like in the vera early days, the visual perception is quite tolerant to slight temporal deviations. This is different with auditory signal replay.

Deconstructing the historical sense of time from within technological media

To what degree does the historicity of sound depend on its material embodiment? Phonographic "engraving" is sound in latency. The ontological status of recorded sound is waiting to be activated (German "in-Vollzug-Setzung"), to be "re-presenced" (a term coined by Vivian Sobchack in her analysis of media archaeology). Be it the analog reproduction of temporal wave forms or its digital reverse, the processing of atemporal mathematical frequencies, such "beeing-in-time" is not historical any more, but techno-logical. It requires the media-archaeological ears to understand such sonicity.

Is the sound of an existing Roman era bell dating from the third century a more ancient sound than the sound created by an equivalent bell from present time production, the media archaeologist Paul DeMarinis asks. "For this to be the case we would have to think of the bell itself as an encoding of some 'sound'; that sound, in turn, would have to include the splashing of the molten brass, the beating by smiths' hammers etc. But the sound the bell produces in its current use is far from being a recording of these sounds."; even if the bell stems from the past, its sounding is always present.[165]

[Bachofen experienced it in 19th century Rome: "There is something about the walls of Rome that moves the inmost depths of man. When a metal plate is struck, the iron resounds and the echoing is stopped only by laying one's finger on it. In the same way, Rome moves the spirit that is in communication with antiquity ... all that was slumbering within him." [166] Bachofen's experience results in a more fundamental claim: "There are two roads to every kind of knowledge, the longer, slower, more laborious one of intellectual combination, and the shorter one, the one we cover with the energy and speed of electricity - the road of the imagination when it is touched by the sight and the immediate contact of ancient remains and grasps the truth in a flash, without any intermediate steps."[167]]

A fundamental issue is at stake here: the need to de-couple the question of "temporality" from any narrative concept of temporal sequences which finally questions the notion of history itself.

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165 Paul DeMarinis, According to Scripture [*2002], in: Ingrid Beirer / Carsten Seiffarth / Sabine Himmelsbach (eds), Paul deMarinis. Buried in Noise, Heidelberg (Kehrer) 2010, 247-252 (247)
166) Zitiert nach Gossman, "Orpheus", 46f
167 Quoted here after Gossman, "Orpheus", 49

Once our chrono-analysis is suspended from the historical discourse, a more radical challenge arises which is (among othres) formulated in Timothy Scott Barker's book *Time and the Digital* as well: Is it possible to deal with micro-temporealities without mentioning the transcendent signifier "time" at all - in favour of a multitude of descriptive terms, a "field"?

"Time - today <...> - seems to reveal a new structure and to unfold in a rhythm that is different from the 'historical' time that governed the nineteenth- and the early-twentieth centuries. In this new chronotope - for which no name exists yet, even though we live within its forms - agency, certainty, and the historical progress <...> have faded into distant memory."[168]

Marshall McLuhan already had radically declared in a post-Hegelian mode: "Just as linear history begins with writing, it ends with TV"[169]. History depended on a cultural technique which is alphabetic, linear writing. The "writing" of images and texts on the cathode ray tube for television and computer monitors is of a different kind. Electronic media, therefore, are not just another variance in the history of technology but establish a new kind of temporal reality which escapes the concept of history.[170]

In contemporary society where the grand imaginary and pan-chronic horizon of temporal extension[171] such as religious eternity, the genealogy of nation states or the philosophy of history have been electronically condensed and algorithmically compressed into (or even replaced by) ever shrinking temporal intervals and a focus on the instantaneous present, the close analysis of decisive temporal actions reveals the drama of time-critical media.

In techno-culture an augmented present unfolds, differentiated into a *media dramaturgy* of microtimes; the public radio and TV channels in Germany are even legally obliged to provide online access to a *Mediathek*, a library of broadcasts stored for a week. This is not an archive yet, but an extended window of the present.

Time of the tape: spools, loops

Bergsonean "duration" is like the temporality of a magnetic tape running between two spools.[172] Temporal loops materialize in the un- and refolding tape. In Samuel Beckett's one act drama *Krapp's Last Tape* (1958) the magnetophone itself figures as central memory agency, and its spool represent the loops in which Krapp's autobiographic recursions get lost.

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168 Hans Ulrich Gumbrecht, After 1945. Latency as Origin of the Present, Stanford, Cal. (Stanford University Press), 38
169 Marshall McLuhan, Counterblast, New York (Harcourt, Brace & World) 1969, 122, as quoted in Bexte 2008: 332
170 McLuhan 1969: 122
171 See David Lowenthal, The past is a foreign country, Cambridge (Cambridge U.P.) 1985
172 See Barker 2012; 59, referring to Henri Bergson

Katja Nick has been a circus artist specialized on backward-speaking. As a proof that she did not make up but actually time-reversed reversed correctly what a member of the audience had told her, she recorded her articulation on a specially modified tape recorder which could literally "play back" her reverse-speech performance.

When Katja Nick speaks backwards, she is herself in a machine state.

Not only that the performance of back-speaking is inspired by the dominant reel-to-reel tape technologies of her days, but the magnetophon itself in a stricter sense serves as a non-subjective proof of her claim.

The magnetophone registers unintended presences, a Proustean *mémoire involontaire*:

In the phonographic recording of a performance of Donezetti's opera *Lucia di Lammermore* featuring Maria Kallas as Lucia at the Milano Teatra della Scala in 1954, all of the sudden a radio interference occurs in the act of the primal microphone recording.

Digital sampling allows for a micro-analysis of such signal events, time-discretely temporalising the present.

"Liquefying" the archive

David Lynch's film *Inland Empire* which begins with the image of a spinning record on a record player. "As the needle drifts across the timeles surface of reified sounds, we are, once again, in the realm of mechanical preproduction and the logic of industrial time."[173] The digital fragmentation of time, on the other hand, results in the loss of the chronology and directionality of time which becomes "<...> terrifyingly opaque and illegible for the human subject"[174], resulting in a sublime micro-tempor(e)ality.

With the present as a function of rapid memory operations (both neurologically and digitally), the transformation of the traditional temp*aura*lity of archival storage needs to be observed as well: from archival space to archival time, to the archival "field". Dynamic micro-media memories induce a cultural shift of emphasis from permanent storage to restless transfer. With the aesthetics of re:load, the technological affinity between the archival operation and cybernetics turns out, as manifest in feedback memory and timeshifting. Once these transformations have been analyzed, suspended memory results in total recall.

There are good reasons for questioning the static concept of an "archive" as appropriate term for digital record structures since as a metaphor it is increasingly becoming a hindrance for the analysis of dynamic data storage and circulation. The computer hard disc literally *moves* stored data in post-

173Zoltán Glück, After Midnight, or: The Digital Logic of Time Fragmentation in Inland Empire, in: Munitionsfabrik 19 (2008), HfG Karlsruhe, 8-11
174Glück 2008: 9

structural ways, just like the the magnetic tape did with recorded electronic signals (sound and video) before. The archive becomes *processual* in digital algorithms.

Archival endurance (with its records oscillating between symbolic code and physically entropical decay) is undermined when a record is not fixed any more in a permanent storage medium but techno-mathematical flow replaces the physical inscription.

[Sonic auscultation is an attempt to capture the volatility of sound and reveal its temporal message in a concrete manner through the algorithmic stethoscope, which is software for sound analysis.]

[The video artist Bill Viola in his essay on what he calls the *sound* of electronic images pointed out "the current shift from analogue's sequential waves to digital's recombinant codes" in technology.[175] Sampling and quantizing of acoustic signals analytically transforms the time signal into the information of frequencies which is the condition for technical re-synthesis (Fourier transform). Digitalization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix (chart, list) of its numerical values. Media culture turns from phonocentrism to processual mathematics.]

[The Technical Committee of the International Association of Sound Archives in her standard recommendations from December 2005 points out that any such rules of audio preservation need to be revised when changes of the technological conditions take place.[176]]

Digital operating systems need constant up-dating (in terms of software) and data „migration" amd appropriate hardware to embody them. From that derives a change from the ideal of archival eternity to permanent change - the dynarchive.

[When the transfer techniques of audio carriers changes from technically extended forms of writing such as analog phonography to calculation (digitization), this is not just another version of the materialities of cultural tradition, but a conceptual change. From that moment on, material tradition is not just the function of a linear time base any more (the speed of history), but a new, basically atemporal dimension opens, short-cutting the emphatic time arrow and demanding for a partial differentiation as familiar from the infinitesimal calculus once introduced by Leibniz as a measure of change *within* speed.]

Not yet memory? Focus on micro-storage tempor(e)alities

[Media archaeology as method couples evidence of time-critical human perception *tightly* with technological knowledge. "Data Retention" in fact is most preselby known from static data storage within the computer. To ensure

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175 Viola 1990: 47

176 See http://www.iasa-web.org/IASA TC03/IASA TC03.pdf (accessed June 2011)

that the data in the elementary cell will not be altered, the SRAM (static Random Access Memory) must be supplied by a power supply that will not fluctuate beyond plus or minus five or ten percent. It the elementary cell is not disturbed, a lower voltage is acceptable to ensure that the cell will correctly keep the data. "In that case, the SRAM is set to a retention mode when the power supply is lowered, and the part is not longer accessible."[177]]

Micro-archiving the present: intermediary storage, digital delay

Already electro-mechanic transmission of photographic images *via* telegraph cables in 19th century was performed by intermediary storage, the *quasi*-"digital" data carrier of punched cards and relay amplifiers of the electric signals. This relieved communication engineering from the delicate time-critical synchronisation problem between sender and receiver.[178]

This is known in digital image transfer as well: In the convergence between a repetition and a renewal "lies the tendency to archive while bringing forward"; past and present become instantly simultaneous. "While it loops the past, the digital creates <...> an archival strategy where time passed becomes constantly accessible for the future. Reality's duration seems to have become an archival stream of information potentially open for access at any other time.[179]

The micro-temporal *camouflage*: High Frequency Trading

"Real time" does not exist, but is engineered.[180]

There is a fuzzy present in the Internet. In Internet packet switching, ultrashort-time memory is integral in the technical part of the transmission itself where the traditional contradiction between storage and transmission collapses. With the "hyperbolic temporalities of digitality" <Parikka ebd.>, "network culture is less about clock time but more about delays, latencies.

At the virtual Stock Exchange, time-critial temporalities become economical *tempor*ealties. High Frequency Trading operates with time-"hiding" purposes like these, just like perceptual experiments in the 1960s: smuggling ultra-short

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177Memory 1997 <title>, chap. 8 (SRAM Technology), 8-4 = Smithonian - The Chip Collection (http://smithonianchips.si-edu, accessed May 2014), (Document of the Integrated Circuit Engineering Corportation)

178 See Christian Kassung / Franz Pichler, Die Übertragung von Bildern in die Ferne, in: Albert Kümmel-Schnur / Christian Kassung (ed.), Bildtelegraphie. Eine Mediengeschichte in Patenten (1840–1930), Bielefeld (transcript) 2012, 101–121 (110)

179 Markos Hadjioannou, From Light to Byte. Toward an Ethics of Digital Cinema, Minneapolis (Univ. of Minnesota Pr.) 2012, 174

180 An argument by Jussi Parikka (Wncehstor school of Art), "Of Queues and Traffic: Network Microtemporealities", symposium *Digital / social media and memory*, Univ. glasgow, April 17th, 2013

moments of Coca Cola advertising into a regular TV movie which was not consciously noticed by the viewer.

In High Frequency Trading the beast are time-beasts. micro-temporal worm holes. The focus shifts from macro-temporal economical cycles subsumed as "history" to micro-temporal intervals which undo the emphatic difference between the processual present and the archivized past. Time-critical media analysis in that sense helps to develop to create a new, different, non-historicist language of timings.

For the traditional time-based art forms like literature and theatre, such an analytic language has been developed, encompassing terms like endurance, frequency, recurrence, narrative speed, time-critical occurrence, anachronies.[181] It is time to extend this language to the process which happen within the machines.

The aesthetics of "instant replay"

- Micro-archiving of presence is conceptually and technologically implied in the real-time processing of signals, since as a digital time-discrete sampling and quantizing of moments from the present signal (punctualizing / mathematization the continuous signal event) it requires intermediary short-time storage of data. The concept of real-time and "interrupt" for user input in computing dislocates the metaphysics of pure presence to micro-deferred presence.

In techno-mathematical media which not only allow for re-play of recorded sound but as well interaction and applying intelligent search and sorting on the basis of algorithms, a whole scale of micro-temporal "archiving presence" takes place, starting from ultra-short intermediary storage of electronic equivalents to zero and one in registers and flags, up to time axis manipulations after the digital sampling or recorded audio signals.

The instant archivization of the present becomes apparent with newsradio channels such as German "Inforadio" at radio Berlin-Brandenburg rbb) as frequent errors in (re-)play. What appears like actual news broadcast, by mistake (the new editor pushes the wrong button on his digital control panel) a news just spoken is repeated again. All of the sudden (shock for the "presence" instinct authenticity contract between listener and radio station) it becomes apparent that there is not live transmission any more (Rumanean "trasmissione directa"), but digitally stored ("sampled") sound files - a presence which is "archived" already. The present event and storage merge into one with the increasing digital, i. e.: archiving recording of present spaces. The presence of space itself is being transformed into time-coded snapshots like instant photography by I-pads which step by step ("one bit at a time") *samples* presence.

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181 See Gérard Genette, Die Erzählung, Munich 1994; Hugo Münsterberg, The Photoplay, xxx 1916; Markus Kuhn, Filmnarratologie. Ein erzähltechnisches Anaysemodell, Berlin / Boston 2013

Different to the archive which is symbolical order, recorded by symbols (alphabet), thus: spatial orders, audio-visual media record signals which are physically functions of time. When these are being re-played, our senses are affected, in a non-historical way. There is no memory here, presence happens, like any electronic re-play is dynamic. Instead of psychoanalytic trauma-research, now an analysis of the techno-traumatic momentum is appropriate, about traumatic irritations of re-presencing induced by analog and digital techologies, such as: the phonographic voice of the dead and the real-time presence of archival records in Web 2.0 memories like the video portal YouTube.

"We would make a mistake if we think that <...> we could refer to a 'normal' sense of presence in the present: to an unmediated, integral presence. Nothing as such exists either. We are always anticipating and deferring, missing the presence." We all live with the media archive in both existential and technological ways. "Films, images and videos, here, are time capsules", but not of historical time "but the time of a deferred, diminished presence". A counter-archive would need to give back the presence taken away from present life moment by moment[182] which actually happens on the technological micro-level as analog-to-digital-conversion ("sample-and-hold"). "Archives are always summoned to give back time. But what if they are asked to give back presence?" (Constant ibid.), just like Gordon Bell's *My Life Project* recording project, enabled by permanent data glasses.

The augmented present became practical in the relatively data-poor audio signal processing first: SONY publicised its IC Recorder ICD-SX733 (and other models) under the heading "Recording a few seconds in advance - the pre-recording function".[183] Technical Manuals as ultimate media-archaeological "sources": "The pre-recording function allows you to record sound sources for approximately 5 seconds prior to the point when you press REC/PAUSE. This is useful for recording during interview of when making an open-air recording so that you will not miss an opportunity to start recording" - the extended "window of present" as known from Husserl's *Phänomenologie des inneren Zeitbewußtseins*., in technical acts of re- and protention. The "half-second"[184] which human perception needs to process the present is beaten. The secret of this irritation of the present is a dynamic storage function: "Sounds for 5 seconds are buffered in the memory."

[A self-indexical malfunction (noise) suddenly pops up: "If you start recording with pre-recording function using the built-inmicrophones, a click noise may be recorded when you press REC/PAUSE"; therefore the use of an external microphone is proposed.]

The condition of possibility of "irritating the present" is here, once more, micro-storage. The system offers additional 24 photos in addition to the one actually

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182 Constant, Erkki Kurenniemi (In 2048) (preliminary work towards) an online archive; *online* http://kurenniemi.activearchives.org

183 http://www.sony-asia.com/microsite/recorders_imanuals/ICD-SX1000/gb/contents/TP0000019455.html
184 See Herta Sturm, xxx

shot - which is, maybe not by coincidence, just a "cinematrographic" second of 24 frames.

This is the moment to recall Gottholm Ephraim Lessing's *Laokoon* theorem from 1766. His notion of "the pregnant moment" is exactly *not* identical with the photographic moment of instant photography. Plastic and visual arts, he argues, should rather accentuate the re- and protentive moment, as examplified in the ancient sculpture of the Trojan priest which only hints to his immediate death narratively described in Homer's *Iliad*.

Nowadays, in the age of almost unlimited storage capacities for digital data, the pre-recording mode is replaced by continuous recording - the real-time archive. Pro-active archiving here displaces the traditional repository for records emanating from the past.

"Temporary Storage"

A self-fullfilling prophecy was the disappearance of the entry "Zwischenspeicher / Temporary Storage", in the book *AnArchive(s). Eine minimale Enzyklopädie zur Archäologie und Variantologie der Künste und Medien*.[185] The article very consequently disappeared not as a printed text but in the list of content. Indeed, temporary storage is quite the opposite of the printed text which is a non-rewritable storage medium; in fact that is what its storage qualities mean for academic research: most careful editing of previous versions until it gets its order "imprimatur!"; from that moment on, the author has no chance to change his text *a posteriori*. This increased responsibility and authority - different from the *online* temporality of the Wikipedia encyclopedia with its frequent up-dates. So the entry on *temporary storage* became its own message.[186]

Between the archive and the anarchive there is temporary storage. While archives essentially aim towards long-term, if not even the unlimited preservation of their documents and today`s media archivists grapple desperately with the problems associated with `long-termin archiving", the temporalisation of archives is an anarchival element in the economy of cultural tradition. Archives in motion and `temporary archives` are symptoms of this temporalisation of the archive. The immediateness of the retrieval of immense volumes of data trough online databases contends with an increasingly short-term maximum usability period, which comtemporary culture knowingly accepts. Yet this temporalisation of the symbolic order is predetermined at the operative level of the present itself, namely in the practice of signal and data transmission. Delay lines served the micro-synchronisation of PAL colour television signals as well as the short time maintenance of data words in the

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185 Edited by Claudia Giannetti, copy-edited by Eckhard Fürlus, Oldenburg (Edith-Russ-Haus für Medienkunst) 2014, 175 f.
186 W. E., entry "Zwischenspeicher / Temporary Storage", in: AnArchive(s). Eine minimale Enzyklopädie zur Archäologie und Variantologie der Künste und Medien, hg. v. Claudia Giannetti, ediert v. Eckhard Fürlus, Oldenburg (Edith-Russ-Haus für Medienkunst) 2014, 175 f.

first electronic computers. It belongs to the nature of the so-called new media that they compute and switch , constantly accumulating interim values and then deleting them again. The mathematisation of technical communication by Shannon focuses on coding and the transmission channel which requires discrete temporary micro-storage – an unexpected return of the familiar archival order yet critically radicalised. The stuffy vocabulary of classic archivology shatters on such temporal modes of technological action.

"Time of non-reality": *Totzeit*, negative time

Not only do electronic systems replace perceptible timing operations by subliminal micro-temporal operations (like the clocking and cycling units in digital computing); a new temporal quality emerges with "binary" information theory: Norbert Wiener's notion of "time of non-reality", in fact negative time which does not numerically "count" in binary computing - the real switching moments.

"... ELSE LOOP FOREVER". THE UNTIMELINESS OF MEDIA, or: Does Technology have a Sense of Ending?

In 1936/37, the invention of the Turing machine occurred as an answer to the mathematically undecidable: "Computable" numbers are those which are calculable by *finite procedures*. The question if computer programs have a sense of ending (the *Halteproblem*) leads to the more general consideration of media-induced temporality. Not only that media systems internally develop new forms and performations of temporal sequences and a different notion of "ending" (finite algorithms for recursive functions, real-time operations) and provide of a mirco-dramaturgy of temporal proporties, but they are able to externally address the human perception on its most essential channel of being-in-time. Thus Heidegger's philosophy of *Sein und Zeit* [187] has to be extended to (and is being undermined by) technical media temporality.

Algorithmic time

The media-theoretical perspective starts the question of a "sense of ending" with the very term *medium* itself. By definition, Greek *metaxy* (as defined by Aritotle in his *Physics*, book IV) and its Latin translation *medium* is grammatologically (in logical syllogisms as the "medium term") and technically located inbetween beginning and end, sender and receiver, data input and output, and so forth: as the intermediary, thus temporally ephemeral channel of transmission (as defined by Claude Shannon's *Mathematical Theory of Communication* in 1948), or as the processing unit in computing. Interpreted in this way, the medium/channel always remembers the input and anticipates the output - with a "sense of ending" temporally directional signal processing (such as the so-called von-Neumann architecture of current computers). A current diagnosis states that the current plurality of media itself has already started to

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187 Martin Heidegger, Sein und Zeit (orig. 1927), Tübingen (11th ed.) 1967; 15th ed. 1979

converge into one dominant meta-medium, the interconnected computer, with books and newspapers, film, radio and television finally ending as technically independent media and re-turning in a ghostly shape, as mere formats within the new computational frame (so-called "digital culture"). Is the very term "media" not only an expression of an always already anticipating sense of ending, but itself doomed to end in universal computing.[188]

Culturally, the most common way of information processing is the human-machine communication (and its time-critical escalations, such as comuter games). The temporal constellation which has replaced the narrative, dramatic aesthetics of (tragial or happy) ending, for computer games and human-computer interaction in general, is the mode of *interrupt*. Thus, *kairotic* time replaces *chronos*. Such interactive events between computer and human unfold in ideosyncratic time (based on the "interrupt" mode of computing), rather rhythmically than algorithmically, in contrast to the computational steps that unfold within the computer itself, where instruction-execution histories express an ordering of inner events of an algorithm without any relation to the actual passage of time. "Algorithmic time is intentionaly measured by number of instructions executed <...>. Operation sequences are interactive streams with temporal as well as functional properties, while instruction sequences describe inner state-transition semantics."[189]

To describe the temporal coupling between human and machine on the one hand, and machine-to-machine communiation on the other, Shintaro Miyazaki has introduced a neologism: "Algorhythm", a combination of algorithm and rhythm. Algorithm in computer science means a finite sequence of step-by-step intructions, a procedure for solving a problem, while rhythm is defined since Platon as a time-based order of principally infinite movement.[190]

Finite State Machines and the *Halteproblem*

The question if technological artefacts - "non-human agencies" (Bruno Latour) - have an implicit (physical and/or mathematical) sense of temporality immediately leads to the question whether machines are gifted with "consciousness". The philosopher of cybernetical logic, Gotthard Günther, ascribes to machines the possibility of consciousness - though not self-consciousness (a quality reserved for human intelligence).[191] Consciousness is no material quality, but "a metaphysical instance of existence which can smoothly be translated from one existential 'aggregate state' into another" <ibid., translation W. E.>. This almost literally rephrases Turing's notion of the machinic "states". According to Turing, the computing machinery is at any

188 Friedrich Kittler, Grammophon - Film - Typewriter, Berlin (Brinkmann & Bose) 1986, engl. transl. 1999, Preface
189 Peter Wegner, Why interaction is more powerful than algorithms, in: Communications of the ACM, vol. 40, no. 5 (May 1997), 80-91 (83 f.)
190 Miyazaki 2009
191 Gotthard Günther, Das Bewußtsein der Maschinen. Eine Metaphysik der Kybernetik, Krefeld / Baden-Baden (Agis), 2nd ed. 1963, supplement IV, 179-203 (203)

discrete temporal moment "conscious" of its state when reading a symbol inscribed on the recording tape.

"The theory of automata deals with machines which are intended for production of sequences of machine states. [...] the *finite-state machine*, is an abstract system which has a finite set of internal states."[192] A mathematical calculation thus is a change of the memory state of the machine. Starting from an initial state, passing a pre-programmed sequence of intermediary states a final state is being achieved. Undisputable precondition is the algorithmic structure of the procedure, i. e. a finale state must be achieved with a finite series of steps.

Do computers, in order to be functionally usable, have a sense of ending? For computing in the sense which got dominant in current media culture this question is not an epitemological luxury, but essential. The computer as we understand it (the Turing Machine) was invented by Alan Mathison Turing 1936/37 as an answer to the mathematical *Entscheidungsproblem*. Crudely formulated, the question of ending startet the age of digital media. Turing's machine reasoning was triggered by the *Entscheidungsproblem*.In mathematics, the Entscheidungsproblem (German for "decision problem") is a challenge formulated by David Hilbert in 1928: the search for a general procedure which allows within a formal system to decide if a problem can be solved withend limited time or not. Turing's theorem prooved the impossibility of such a prediction, by transforming the original mathematical-logical question into a temporally determined one: the *Entscheidungsproblem* becomes the *Halteproblem* and thereby a time-critical question ("critical" here in the sense of a necessary decision). Can a Turing Machine decide if another one can solve a problem within limited, ending (German: *endlich*) time? The sense of ending here is transfigured into a new from of dealing with infinity, as cultivated by transfinite mathematics (Cantor). The Turing Machine (which is mechanized mathematics) is to be understood from the dynamic perspective of temporal processuality. "The writing head of a Turing machine inscribes symbols one by one in an infinite string, giving rise to time as a sequence-stream."[193] The strict sequentiality of the Turing machine and its operational table embodies an element of intuitional mathematics contrary to Hilbert's self-referential play of symbols: the hypothesis of a temporally structured, sequentiality, as known from human consciousness.

Finite-state machines operate as linear sequences of events in time.[194] These events happen as discrete moments with nothing happening inbetween (the "time of non-reality", as once casually named by Norbert Wiener). This

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192 Teuvo Kohonen, Self-Organizing Maps, Berlin / Heidelberg / New York (Springer) 1995: 16; see idem, Self-Organization and Associative Memory, Berlin / Heidelberg / New York / Tokyo 1984
193 Francisco J. Varela, The Specious Present. A Neurophenomenolgy of Time Consciusness, in: Jean Petitot / same author / Bernhard Pachoud / Jean-Michel Roy (eds.), Naturalizing Phenomenology. Issues in Contemporary Phenomenolgy and Cognitive Science, Stanford (Stanford UP) 1999, 266-316 (268)
194 Marvin Minsky, Computation. Finite and Infinite Machines, Englewood Cliffs, N. J. (Prentice-Hall) 1967, 12

temporal rhythm might be compared to the ticking of a clock - numerical variables for time *t*.

The *Halteproblem* (among other *Entscheidungsprobleme*), to repeat its essential feature, searches for an algorithm to decide, if programs, automata or computer will stop in case of certain or all inputs or not. Almost paradoxically in the context of "the sense of ending", the question of ending in the Turing Machine as *finite automaton* is based on the (purely theoretical) assumption of an infinitive, endless storage tape for intermediary notation. The configuration of a loop, the iterative principle, and recursive procedures are the predominant *chrono-tropes* in computing time. But the loop structure has been already characteristic of the classic magnetic tape (reel-to-reel). Let us repeat: "loop forever"; this reminds of Samuel Beckett's play *Krapp's Last Tape* (first performed in London 1958) which ends with the director's note "tape runs on in silence" - an endlessness which has been answered by technology by introducing the auto-stop mechanism at the end of a tape. There is a growing asymmetrie between media time (the tapes which re-play Krapp's voice invariant to temporal progression, whenever it is subjected to the magnetic recorder), and Krapp's biological existence which is subject to aging (that is: entropy).

Any enjoyment of a musical performance which is done by real humans in real time and space (be it oral poetry as sung by Homer, be it a muscial concert) is always already accompanied by melancholic knowledge (that is: the irony) of its ending. On the contrary, audiovisual machinic recordings (the gramophone disc, the video tape) can be replayed with no internal sense of ending. To modify Walter Benjamin's analysis on "The Work of Art in the Age of Technological Reproducibility", with technical re-petition the temporal aura (which is based on the allegorical awareness of ending) is lost. But the re-entry of temporality happens within the very signal processing of technological media. "Zeit" in German is a noun, suggesting substantiality; in English, though, there is as well the verb *to time*, *timing*" - and only Heidegger dared to make use of the word "zeitigen". The same structure happens for "end" ("Ende"), leading to *ending* - a temporalization of "time" and "end" themselves.

Being-to-death (Heidegger)

Marshall McLuhan named it in 1964, in his classic *Understanding Media*: The message of a technological medium is the change it induces with the frame of reference, the speed and schemes of the human situation. Audio-visual media address us at the essence of our sensation of being which is the temporal sense. They re-generate temporal experience, thus adressing the human on the sensory (aisthetical, physiological) level as radically present, while our cognition puts it into a "historical" context: here, a dissonance takes place, a gap opens, a *différent* in Jean-François Lyotard's sense (referring back to Kant)*.

According to Heidegger, it is the knowledge of death which inscribes a temporal vector into the human sense of being, so-called existentials ("Existenziale"). This cognitive horizon anticipates death always already.[195]

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195 Heidegger 1927 / 1979: 234

Humans live with the implicit awareness that their death is already future in the past, a dynamically deferred *futurum exactum*. This pattern escalates dramatically within electronic media, turning Heidegger's question from an ontological one into an analysis of micro-temporalities which take place there, critically. Heidegger's ontological archaeology of temporality within human being is decisively anthropocentric, explicitely opposed to reified time as embodied in a trivial machine: the mechanical clock. But with the cultural mastering of electro-magnetism (electronics and computers) a form of processing temporal moments came into the world which unfolds a temporal *kosmos* of its own, its very own chronosphere which needs (analogous to Heidegger's analysis) a *media archaeology*, practicing not "ableitende Begründung", but "aufweisende Grund-Freilegung"[196], uncovering the eventuality, which is: temporality (and finiteness) of being[197]. Let us perform this time-critically, that is: on the micro-temporal level of electrophysical media.

To translate the Heideggerian analysis of being-as-time to computing: Once a computing mechanism is in the (physical) world, it is subjected to temporalities. This is the "subsymbolical level" (Martin Donner) of physically implemented logics (mathematics). Media-ontological analysis reveals no static being, but the essential processuality of media-time (their operativity). The being of technical media is incompatible with a motionless ontology.

Computing (with) time

In mathematics, Newton and Leibniz have developed a might tool known now as differential and integral calculation in order to cope - for the first time in occidental intellectual history - with temporal objects, notably speed and acceleration, as opposed to discrete mathematics which has combinatorial subjects (like the digital computer). "Analogue" computing has such a sense of (physical) time, different from numerical computing. Numerical mathematics constructs discrete algorithms to cope with continual mathematical problems, in two models: direct computing which after a finite temporal process delivers the exact solutio, and approximation. Numerical procedure replace a continuous mathematical problem by a discretes, that is: finite problem, at the cost of errors which results from the very act of quantization (such as sampling). There is a kind of "digital computing" *avant la lettre* which lacks a sense of ending because of its very repetitive measuring of time itself - the automated clock driven equally pulsed by the escapement mechanism, an oscillaltor literally counting - that is, *computare* - time, with a sense of temporal flow. Heidegger criticised the "digital" time produced by measuring media such as clocks. It was Aristotle, who in book IV of his *Physics* has defined time resulting from measuring movement sequentially by numbers. Heidegger opposed „vulgar" mechanical time - as defined by Aristotle as countable, and objectified in the ticking clock - by „essential" time[198]. Countable time as represented by clocks are a form of periodic measuring, in the sense of the experimental order as developed in the natural sciences.

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196 Heidegger 1926/1979: 8
197 Heidegger 1926/1979: 375
198 Heidegger 1927 / 1967: 421

Ending as a function of memory *versus* endless delay

For any symbols and signals there is the problem of limited memory capacity, both in humans and in machines. At this point there is a rupture between semiotics and computing respective neurobiology: While symbols are timeless abstractions for notation, signals are physical beings which take place in time (the "real"). By signal processing in data modelling it is easy to gather a great deal more information than can ever be represented in artificial, localized memory systems. The notion of infinite-state memory (and organizational memory) is familiar from systems theory, especially from the theory of adaptive filters. In this model, the parameters are *recursively updated* by all the received signals, whereby they can be regarded as a kind of memory for all received information. "It seems that the human memory <...> operates in this way."[199] On the other side, there is dynamic memories as developed for early electronic computing: (ultra-)sonic "delay lines" and "iconic" intermediary storage, the so-called Williams Tube, keeping pulse trains (which embody "data", bits respectively "words") in latent memory until they are used (addressed). The endless delay of the moment of ending is a chrono-rhetorical figure known in Christian religion as *katechon* (articulated by apostle Paul). Already in the world of mass media, starting with the original radio Soap Opera and culminating in television *serials*, the performance of end-less time, the time of endless deferral (the *katechontic*) has become a cultural form. "Siegecraft, once the art of defending the strategic cities of European states, has become the art of defending the archive" <Richards 1992: 124f>.

In many ways, recycling replaces the teleological direction ("sense") of ending - a temporal vector once scientifically objectified by the Second Law of Thermodynamics (entropy).

Writing and Time

The chrono-entropical directedness of physical (thermodynamical) time becomes "final destination" by the hypothesis of a discursive imaginary called history; *sense* (ital. *senso*) und *end* thus converge asymptotically. The frontispiece of Lafiteau's *Moeurs des sauvages Ameriquains* (1724) shows the encounter of writing and time in a closed space littered with relics from both Classical Antiquity and the New World. The muse of history (Clio) holds the pen, the allegory of time (Chronos) the scythe (in German: "Sense", another *senso*); both tools approach each other asymptotically without ever touching.[200]

The idea of historical time, according to Vilém Flusser, is an implication of alphabetic writing which reduced the multidimensionality of architecture and images to linear, sequential lines. According to Marshall McLuhan, the invention of the printing press, i. e. the mechanized form of alphabetic writing as a further escalation, gave rise not only to perspective in Renaissance painting,

199 Kohonen 1984: 21 f.
200 Michel de Certeau, Writing versus Time, in: Rethinking History, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980)

but as well "print produced the idea of a past in distant perspective"[201] which is directional, end-orientated time. Historical consciousness, read this way, is the direct function of a specific media technology. The loss of historical consciousness as reference for the selection of information in combination with the increasing technological manipulation of time leads of the simple storage of all incoming data - starting with the E-mails on almost every private computer desk. The end of history is the future of the archive, a kind of post-historical condition not to thing in linearities any more, but to calculate with discreet states. Storage, according to the mathematical theory of communication engineering, is the pre-condition for all transfer.

The moment when facts are disseminated by news media, they gain a kind of kinetic energy which divorce them from their original context and throw them into hyperspace where they loose any pointed direction, de-referentialized, with no more teleology (which is the condition for the discourse of history as sense-driven narrative). When events are not only registered but as well written (~~historio~~-)graphically with no more sense of ending, what remains in the end are listings - a reduction of narrative to its essentials, like On Kawara's "date art" paintings. The artistic writing systems of Hanne Darbovens as well turn what used to be narrative historiography into lists of dates (e. g. *Bismarckzeit*, 1978): pure serial writing (corresponding with the computational *histoire sérielle* in the Franch school of historians around the journal *Annales*), pure description. Narrative elegance is being replaced by mathematical procedures of time series.

Game time

In traditional media the relation and distribution of linearity and non-linearity mostly converges with the patterns of narrativity. Narration produces in its classical structure of beginnging, midlee and end, a linearly unfolding sequence which allows for non-linear couplings, differering according to the individual laws of media. While movies represent closed blocks of length, television developed the weekly series and its repetition. With hypertextual media (computer games, and the World Wide Web), non-temporal modes of beginning and end become aquainted: hypertime. The point and moment to step in is almost arbitrary.

Expressed in the mathematical theory of graphs, an adventure-computer game is defined by a beginning and an ending (almost „Homeric narrating", according to Erich Auerbach): everything which happens between point *a* and point *b* in binary space partitioning.

While human memory remembers the same response to the same signal, a counting function counts it different each time <Spencer-Brown 1994: 65>. This is non-narrative time in action, replacing *raconter* (in French) by *conter*, disrupturing narrative (German "Er/zählung"). For the first time, in the so-called digital age historiography does not take place on the symbolical level of the phonetic alphabet exclusively, but on the level of electronically embodied alpha-numerics. In binary form the year 2000, f. e., appears as numerical string

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201 McLuhan 1962: 58

„11111010000", reminding us not to be seduces by narrative suggestion, but to calculate in discrete states, with the consequence not to tell events intransitively but to count them transitively, quantizing data. The media theorist Lev Manovich (in a chapter of his book *The Language of New Media*) calls this the aesthetics of data banks, corresponding with a data-archaeological information ascetitics. Beginning and end, in computing media, are not structured by dramatical structures any more, but by the (equally complex) logic of *count down*.

The "Y2K problem" and the non-sense of ending

Years ago, a computational problem (both in Arno Borst's sense of medieval *computus* as time-counting and in the sense of mechanized data processing) almost led to a collective panic for the so-called post-industrial information society: the *millenium bug*. The so-called "millenium bug" reminded our information society of its very temporal being-to-death. There is a close connection between the temporal, destinational logic of narrative texts and apocalyptic expectations. Most computers so far had been programmed in such a way that the step into the 21st century - without laborious intervention - meant a jump back in time, so the 1st January 2000 was indicated as the 1st January 1900. The reason for this lied hidden deep within the operating system - a media-archeological *deep time*. The jump from 1999 to 2000 (in chronological time) as a jumping back to 1900 (in computational time) was not biased by philosophical musing on the ende of history any more, but has been triggered by integrated circuits. The computer-temporal bomb namend the Y2K problem reminded the post-historical society drastically that its temporal order is no more a function of philosophy of history but of data storage economy, since in the early years of digital computing memory space had been the most precious commodity. Thus the Y2K-problem turned out to be a function of the technomathematial archive to which the philosophical notion of "beginning" and "end" is alien. The *millenium-bug* thus turned out to be (like all katastrophies) a chance as well: the liberation from the cultural supremacy of narrative. With the "millenium bug", the mighty cultural engineering of calendar time turned out to be no more the priviledge of the church (like in medieval times) or of learned societies (like in the modern age). Calculating time turned out to be a technical historicity from now on - a temporality to which human concepts of time are increasingly subjected.[202]

"Ubiquitous oscillations" *versus* transient phenomena: Signals of ending in electronics

Active sonar in submarine communication creates a pulse of sound called a "ping", and then waits for reflections of the pulse. The time from emission of a pulse to reception is being measured, traditionally by use hydrophones to measure the relative arrival time to each in a process called <Wikipedia>. The ping signal, when fading out, resembles the outfading oscillations in early

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202 See Jean Baudrillard, Das Jahr 2000 findet nicht statt, Berlin (Merve) 1990; same author, The Illusion of the End, Stanford, Cal. (Stanford University Press) 1994

spark-driven telegraphy which was turned into stabilized, continuous oscillations only by the electronic vacuum tube in feed-back circuits. Only this allowed for the transmission of carrier-wave-modulated speech and music, as opposed to discreet Morse code. Let us compare this with the process of a swinging string. A pulled string at an instrument with a fading pitch anticipates the infinite swinging out from the sudden, transient start. In the real, that is: physical world the picked string fades out during to mechanical loss of energy (Heidegger's "being-to-death" in its mechanical sense), like a swinging pendulum, like the echo in the sonosphere. It was the temporal delay manifest in echo acoustics which already led Aristotle to the hypothesis that there must be a resistant "inbetween" (in this case: the air) which functions both as a carrier and a restistance to the propagated sound - *to metaxy*, giving birth to the first genuine media theory.

Both the pulled string and the articulated echo, by their very fading out, reveal the *endlichkeit* (the temporal limit) of any physical event. The moment a string is pulled or a sound is articulated, like a breaking wave, nature already anticipates and senses its very end, almost instantaneously but strictly temporal (like electromagnetic induction which is - as calculated by James Clerk Maxwell - very fast indeed but not instantaneous). In 1879 Hermann von Helmholtz initiated a prize by the Berlin Academy of Sciences to answer the dispute on the essence of electricity: the theory declaring no wave-like transmission but rather an immediate reaction (in the tradition of Newtonean physics) *versus* Maxwell's mathematical theory of electromagnetic waves as part of an encompassing electromagnetic spectrum like light, thus subject to temporality, a limited speed. Radio waves, as turned out by Heinricht Hertz' experiments on the very media-archaeological level (that is, before becoming part of a mass-medium called "radio"), have a *sense of ending* on the very electrophysical level; the secondary level is the modulation of the carrier waves by the proper radio program which by its very format nature is ending by arbitrary cultural and media-economical decisions.

Time-to-live and ping-to-death: Internet temporality

There is an operative use of "signs of ending" on the micro-temporal level which is the operative temporality of electronic media: linearities which are nevertheless not narrative, and discontinuities which are the precondition for what human physiologically perceive as continuous movement in space (the kinematographic effect). The electronic (analog) image on the television screen is being scanned by the scanning finger of the cathode tube ray line by line. After such a line has been completed, a special signal indicates the cathode beam to jump back to write another successive line. A different kind of synchronization impulse indicates the completion of whole image frame, to start anew.

The programming of computers always involves a local sense of ending, since it has to pay respect to the time-critical question of data-synchronisation. When a code is literally "run" by the machine, a so-called *profiler* finds out how long the machine takes for the respective operations. A similar time-critical mode is true for communication in the World Wide Web. The ICMP protocol operates on the basis of echo request and echo reply. The source computer sends small data

packets of the type echo request to the destination computer. In case these packets reach their destination, it replies with the type echo reply; thus the data connection between two machines can be chequed and disturbances be detected. But these control data can be misused, leading to the so-called "ping of death" and ping flooding. "Ping of death" stands for oversized data packets which once lead some TCP/IP stacks to collapse, destroying the machine configuration. "Ping flood" means the echo requests are being targetted with the highest possible speed; the destination computer thus is so busy with answering that he can almost not be used for its poper tasks any more. In TCP/IP as fundamental network program, techniques of synchronisation meet a deadly economy of time. "Time to live" means that each daten packet is assigned a given life span; "Time to die" stands for the crucial signature of the information age.[203]

A mathematical anticipation of ending

Techno-mathematics operates in an *untimely* mode (to make use of Friedrich Nietzsche's German notion of "unzeitgemäß"). Oswald Spengler starts volume I of his classic *Untergang des Abendlandes* with his notorious chapter on "The Sense of Numbers".[204] He criticizes modern "Faustean" science for its emphasis on mathematical laws of causality which do not catch the unpredictability of life which is rather a function of destiny. According to Spengler, future live can be *sensed,* but not calculated*.* Soon after Spengler, Western science managed to cope even with destiny and unpredictability in mathematical terms: linear prediction by stochastic calculation and harmonic analysis, as developed by Norbert Wiener. Linear prediction (which in linguistic grammar is *futurum exactum*) pracitcally means the anticipation of the past in the future. This *chronotopos* of "past in the future" has been developed as a mathematical tool for anti-aircraft artillery in the Second World war, leading from the analogue computer (Vannevar Bush's Differential Analyzer) to the first electronic computers.

With anticipatory targeting, such a directional "sense of ending" opens a temporal horizon, in fact: it temporalizes the apparent momentary presence into an augmented presence. What has been described by Edmund Husserl (examplified by the human capability to grasp a musical melody) as "inneres Zeitbewußtsein", a temporal horizon consisting of re- and protentions, has become technomathematical in real-time computing (since the stored program computer, the so-called von Neumann architecture of computing) which - seen under that aspect - is "musical" in character. Indeed, this form of temporal integration is known from human physiology and in linguistics, when it comes to semantic pro- and retention in sentence-building, such as the backwards-correction of the meaning of a word.

Sensors for targets (rockets, trajectories)

203 Sebastian Gießmann, Netzwerk-Zeit, Zeit der Netzwerke. Fragmente zur Datenökonomie um 1960, in: Volmar (ed.) 2009, 239-254
204 Oswald Spengler, Vom Sinn der Zahlen, in: Der Untergang des Abendlandes, vol. 1, Munich (Beck) 1923, 71-122

The meaning of the end and the sense of ending are closely coupled. There is a complex and controversial relationship between the ideas of the end and of sense, with "sense" here referring to the physiologically sensual (neurologically and electro-technically) signal-based, but to "meaning" as well - an ambivalence kept in Italien (*senso*). Let us look at the plurality of semantics. Latin *finis* means border, limit, end, achievement, goal, final aim, purpose, equivalent here to Greek *telos*. It has been a technological paradigm of 20th century communication theory, in fact *cybernetics*, which gave a hitherto metaphysical notion an epistemological twist for both humans and machines, as expressed in Norbert Wiener's writing on "Behaviour, Purpose, and Teleology", cultivating a non-deterministic, still teleologically orientated theory of feed-back.[205] Between target and destruction, on one hand, *finis* means end and ruin, whereas, on the other, result, achievement, aim. This polysemanticity is kept in Italian, but as well is resonant in elaborate German language, f. e. in G. W. F. Hegel's notion of the "end" of art ("Ende" here equals "Vollendung", fulfillment).

Techno-mathematics is less metaphorical here, or expressed the other way round: it is literally metaphorical (with "metaphor" naming "transfer"). In ballistics, the final destination has been a function of mathematical calculation, giving rise to a plethora of new methods. A shell [Geschoß] has to be imbued with an in-built "sense of ending" in order to arrive at its planned destination, culminating with the German V1 rocket in World War II and its pre-calculated trajectory. With the V2 rocket a further escalation happened: A self-correcting mechanism (a kind of Analog Computer, the in-built "Mischgerät") was able to correct aberrations during the trajectory ("on the fly") - a technomathematical sensorium of ending. We know the image from Iraq War II: The ending of the trajectory is the final hit of the missile which corresponds with its self-destruction, as expressed by the title of David Mindell's Ph.D. thesis in 1996 (Cambridge, Mass.): *Datum for its Own Annihilation*. But still, the trajectory is planned to be more or less linear and allows for linear prediction.

An epistemologically more delicate situation arrives with the anti-aircraft artillery in WWII, when the "enemy" pilot is expected to try to manoeuvre around the artillery trajectories. The artillery thus has to anticipate not only the immediate future position of the enemy aircraft, but as well the possible counter-manoeuvres of the pilot to escape this linear prediction. For that reason, a modification of the trivial pre-calculated fire tables has been developed which lead to the rise of a mighty technomathematical tool: the electronic analog, then: digital computer. The Mark 1 Ford Rangekeeper on a battle-ship in World War I had the purpose to calculate *in real time*, that is: in the medium of temporality itself (as the only stable variable) the enemy ship's course and speed, to extrapolate these data into the future, and the to aim where it was expected to be: a mathematically "calculated" sense of ending, embedded within a mechanic analogue computer. If one entered an inital range, the machine calculated the range into the future. A similar mechano-mathematics was applied in the later Sperry T-6 anti-aircraft director. "The computer performed <...> *prediction*, or leading the target, modeled its motion

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205 Norbert Wiener, Behaviour, Purpose, and Teleology, in: Bulletin of Mathematical Biophysics, vol. 5 (1943), 114-133

and extrapolated it to some time in the future."[206] The figure of time here is the grammatical future-in-the-past, based on a feedback operation. Ballistic and prediction calculations formed a feedback loop, with the aim of minimal dependance on the so-called human element.

A photography of a German rocket attack, reproduced in Mindell's media-archaeological analysis, shows continuous and discrete signals agonistically coexisting in the air - the anti-aircraft-system shooting down a buzz bomb. The missile enters at the left, is hit by a shell, crashes, and explodes. The white dots are shell explosions, which continue to statistically track the predicted position of the target."[207] This is the appropriate moment for this text, to "end" as STOP.

SIGNALS IN ACTION. An Archaeology of Time-Critical Infrastructures within Media Technologies

Time-critical media

Philosopher Ernst Cassirer once pointed out that a technical being can only be captured during its actual operations.[208] This distinct quality counts all the more for the technological escalation into electronic media: They are in their medium-being only when signal processing, electrically biased, "under voltage". This makes them especially sensitive to micro-temporal intrusion, irritation and manipulation - much more than previous cultural techniques like alphabetic writing which became time-critical only when coded into electric telegraphy.[209]

In electronic television, the exact synchronisation, thus timing, of signals becomes crucial for its success in the human *aisthesis* of image perception indeed. With techno-mathematical computing where minimal temporal moments become critical for the success of the whole process of internal calculation and human-machine communication ("interrupt"), time-criticality becomes a new epistemological object in the economy of knowledge. Since in media culture events are rather computationally counted than textually narrated, time-criticality needs to be focussed by process-oriented (thus dynamic) media archaeology.[210]

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206 David A. Mindell, Between Human and Machine. Feedback, Control, and Computing before Cybernetics, Baltimore / London (Johns Hopkins University Press) 2004, 20
207 Mindell 2004: 256
208 "Das 'Sein' der Technik läßt sich selbst nicht anders als in der Tätigkeit erfassen und darstellen." Ernst Cassirer, Form und Technik, in: idem, Symbol, Technik, Sprache. Aufsätze aus den Jahren 1927-1933, ed. Ernst Wolfgang Orth / John Michael Krois, 2nd ed. Hamburg (Felix Meiner) 1995, 39-91 (48). I owe this reference to the precise media-archaeological monography by Ricardo Cedeno Montana, Portable Moving Images. A Media History of Storage Formats, Berlin / Boston (de Gruyter) 2017, 13
209 Florian Sprenger, Medien des Immediaten. Elektrizität. Telegraphie. McLuhan, Berlin (Kulturverlag Kadmos) 2012

Time-critical signal archaeology is not simply concerned with so-called "time-based arts" (which start with oral prosody and theatre already, leading to film and other mass media dramaturgies) but with *kairotic* media technologies. Time-criticality in its media-technological context does not refer to a philosophical or critique of contemporary politics or ethics but rather to a special class of events where exact timing and the temporal *momentum* is literally "decisive" for the processes to take place and succeed at all.

Video artists like Nam June Paik and Bill Viola have articulated electronic media temporality, transcending simply time-based performances (like theatre) towards an archaeology of such time-critical processes. In its ancient Greek sense, *crisis* refers to the chances of decision, with its temporal form being an impulse rather than a duration or narrative - *kairotic* time. Kairos - the ancient Greek god of the decisive moment - becomes proverbial in post-modern just-in-time production in both industry and technologies, as well as in deadly situations like anti-aircraft prediction in Second World War.[211]

In its etymological roots, "time" itself refers to divisions of continuity, to the cutting edge. Apart from its long aesthetic tradition, the cultural impact of time-criticality escalates with (and within) technological media, starting from photographic exposure time which almost shrank towards zero. Signals which are operated with electronic speed can hardly be followed by human consciousness like, for example, symbols (printed letters) in textual reading. When signal transfer happens below human sensation, it can be spotted only by time-critical observation. For subliminal events the true archaeologist of time-critical knowledge are technical media themselves; only with the emergence of hightly sensitive measuring instruments since the 19th century time-critical processes like the runtime of signals within human nerves became analyzable at all.

The analysis of time-critical signal processing both in animals and in machines reactivates previous cybernetic assumptions under the specific perspective of micro-tempor(e)alities. The acknowledgement of the unity of perception-in-action implies the notion of time-critical signal processing, encompassing both electronic and technomathematical systems.[212] Time-critical signal processing as a topic of applied mathematics - in the neo-cybernetic sense - does not refer to electrical engineering only, but to organic bodies as well.[213] Signals of interest range from sound, images, and sensor data to telecommunication (such as radio signals). Technical media, in this context, act as agents of signal

210 See Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009

211 See Siegfried Zielinski, Archäologie der Medien. Zur Tiefenzeit des technischen Hörens und Sehens, Reinbek (Rowohlt) 2002, 43

212 See Norbert Wiener, Cybernetcis or Communication and Control in the Animal and the Machine, Cambridge, Mass. (M.I.T. Press) 1948

213 See, for example, J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry (ed.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 372–389

analysis: biological data (from the human body) are retrieved (and transformed) by time-varying measure media such as sonography, electrocardiograms.

Techno-logical clocking *versus* religious timing

Coupled to ubiquitous time-keeping technologies, man becomes a servomechanism of his clock. McLuhan concludes: "This continuous modification of man by his own technology stimulates him to find continuous means of modifying it", resulting in time-critical symbiosis.[214] Such an analysis brings together disciplines which are usually separated in the academic faculties: humanities, engineering, cultural studies, mathematics, neurosciences, media studies.

The relation between operative technologies and performative culture, considered on the media-archaeological level, concerns nondiscursive regimes with an inherent chrono-logics of its own. Are humanly triggered technologies - once they have become operative - indifferent to the question whether they have been installed out of a discursive bias or not, even if they bear the imprint of this bias in technical form? Is there any close association between cultural techniques like liturgy, e. g., and the algorithm as mathematical procedure? What differentiates general cultural technologies from genuine media technologies, and is there a non-cultural, auto-poietical element at work in technical media? Discursive metaphors both create and obscure media practice. An analysis of the techno-procedural *arché* (rather than simply historical "origin") of the oscillating mechanical clock from late medieval monasteries focuses on the epistemological dis/continuity from religious timing to genuinely time-based media processes, resulting in an awareness of differential oscillations (Huygens, Mersenne, Maxwell, Hertz et al.) which both separates and re-alignes the Pythagorean cosmology from the electro-technical and techno-mathematical media age. If time-measuring media is more than simply an assembly of technologies (tools, material artefacts) but depends upon the existence of a wide range of sensorial techniques which drive and modulate their specific development, the religious system of co-ordinated action comes under consideration. The relationship of religion and technology is a provocative one; they do not take on a common ground but belong to different realms of practice and experience. For Ernst Cassirer, in a somewhat paradoxal definition, "symbolic forms" such as myth and art (among others) are "the specific media created by mankind in order to dissociate itself from the world and thus be re-united with the world the more firmly"[215] - *religio* as a special kind of symbolic action.

A case of a religious encounter with a technology is the numerical measurement of time. With the invention of the escapement-driven mechanical clock within the context of Benedictine monasteries which are based on strict

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214 See as well J. C. R. Licklider, Man-machine symbiosis, 1960
215 "[...] die eigentümlichen Medien, die der Mensch sind erschafft, um sich Kraft ihrer von der Welt zu trennen und sich eben in dieser Trennung umso fester mit ihr zu verbinden": Ernst Cassirer, Zur Logik der Kulturwissenschaft, Göteborg 1942, 25

temporal discipline, the sensation of micro-periodical oscillations entered the occidental chronosphere.[216] Remarkably, the origin of the oscillating clock stems from the climax of liturgic practice. From such techno-logical coincidences, media archaeology rather seeks to develop alternative frameworks for understanding shifting relationships between humans and machines in diverse and even distinct cultural traditions. The oscillating clock started as a technique in religious timing, but auto-logically generated a non-human mechanism, setting anartificial time-base. While apparently grounding in religious belief of world-order, the resulting techno-mathematical work auto-poietically started to develop into a world of its own.

On the one hand, only in combination with a Christian sense of temporal linearity and stimulated by a religious idea of infinity (since Augustinus) the question of time became open to be implemented in *operative* timing media. This mechanism, once it has been at work, rather unsconsiously and paradoxically emancipated occidental culture from its dependency of cosmic-religious time.

The paradox might be formulated like this: In terms of cultural performance, the rhythmic sense of periodic beats is closely linked to monastic prayer and working practice, but triggered a rather nonreligious take-off in the awareness of operative oscillating mechanisms (the vibrating string, developing modern acoustics and other wave analysis to be synthecised in electronic media and the timing mechanism of computing itself.

In early 19th century, oscillation became even an epistemological term.[217] As Hans Christian Ørsted remarked, if a human imagines a monochord string making its slowest vibrations, he might still be able to distinguish each vibration with our own eyes. But let the speed increase, "now we can no longer distinguish one vibration from the other; we see only the entire space through which the string vibrates filled by it. There is a gap between the point where the visibility of the individual vibrations ceases to the point where the deepest tone begins. Now imagine the vibrations proceeding with increasing speed and producing higher and higher tones"; in the end the speed of the vibrations becomes too great even to be perceived by the ear.[218]

A most efficient device for intermediary storage of data in electronic high speed computing, the mercury-based acoustic delay line as Random Access Memory, required clocking for a sufficient synchronisation with the processing unit. "We might say that the clock enables us to introduce a discreteness into

216 See W. E., Ticking Clock, Vibrating String: How Time Sense Oscillates Between Religion and Machine", in: Jeremy Stolow (ed.), Deus In Machina: Religion, Technology, and the Things in Between, New York (Fordham University Press) 2013, 43-60

217 See Bernhard Siegert, Passage des Digitalen. Zeichenpraktiken der neuzeitlichen Wissenschaften 1500-1900, Berlin (Brinkmann & Bose) 2003

218 Hans Christian Ørsted, Experiments on Acoustic Figures [1808], in: Selected Scientific Writings of H. C. Ørsted, trans. and ed. by Karen Jelved, Andrew D. Jackson, and Ole Knudsen, Princeton (Princeton Univ. Press) 1998, 280 (brought to my attention by David Trippett)

time, so that time for some purposes can be regarded as a succession of instants instead of a continuous flow. A digital machine must essentially deal with discrete objects."[219]

New kinds of bio(algo)rhythmization

The sense of measurable prosodic "beats" (*chronoi*, in Aristoxenos' term) is related to the engineering of poetic timing and the the discretisation of poetic speech articulations into distinct letters by notation (vowels and consonants), inducing its automatization and technological implementation.

The memory technique in oral poetry performances (by singers of epic tales) relies on senso-motoric synchronisation and feedback, sometimes significantly coupled with a string instrument (Homer in Greece, *guslari* in ex-Yugoslavia). "Aucune activité de la matière ne peut échapper au rhythme" (d´Udine[220]). "La diffusion nerveuse est comparable à la propagation du courant électrique à travers un réseau de fils conducteurs."[221] Embodiment as form of *kinesthetics* epistemologically activates the assumption that both machines (technical or mathematical) and animals are governed by analogous feedback-processes.

The bio-rhythmical human experience of time (so-called "circadian time") as alternation of acticity and rest over the course of day and night is of almost musical nature - rhythmic. As remarked by McLuhan in his *Understanding Media* (1964), the electric light has already profoundly irritated this rhythm by extending the day-time by an articial medium ("electric light"). Television consumption (which had been the occasion for McLuhan's study) increasingly structured human attention different from the traditional circadian time rhythm. In times of pervasive *online* computing, this rhythms becomes coupled with the algorithms of computing itself. Increasingly, the rhythms of human activity are shaped less by natural environmental cycles like the presence or absence of daylinght, but "more by rhythms in the data streams that occupy an ever greater share of our attention"[222]. So the "algorhythmic"[223] is no longer simply *within* the computing machinery, but it affects human temporal experience as such in a hybrid way - whenever human time and machine time are being directly coupled.

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219 Alan Turing, Lecture to the Mathematical Society on 20 February 1947, in: The Charles Babbage Institute Reprint Series for the History of Computing, Bd. 10, A. M. Turing's ACE Report of 1946 and Other Papers, Cambridge, Mass. 1986, 111

220 As quoted in: Marcel Jousse, Le Style oral rythmique et mnémotechnique chez les Verbo-moteurs, in: Archives de Philosophie vol. II, Cahier IV: Études de Psychoogie Linguistique, Paris 1925, 10

221 Jousse 1925: 17

222 A core thesis of Josh Berson, as expressed in his lecture on "Circadian Selves", February 11th, 2013, at IxDA Munich. See http://www.ixdamunich.de/2012/12/18/february-11th-circadian-selves-a-presentation-by-josh-berson (accessed February 20th, 2013)

223 Shintaro Miyazaki, Algorhythmisiert. Eine Medienarchäologie digitaler Signale und (un)erhörter Zeiteffekte, Berlin (Kulturverlag Kadmos) 2013

Culturally, a familiar way of information processing is the human-machine communication and its time-critical escalations in computer games. Such action / reaction loops were first tested in the psycho-physiological laboratory of Wilhelm Wundt at Leipzig University around 1900 with its central artefact being a telegraphic device coupled to a chronograph in order to measure the minimal delay time (*delta t*) between incoming signal and human nervous reaction.[224] Computer games are time-critical, with micro-temporal moves and short-time neurological memory. The message of the medium computer games is not stories, but instant feed-back. Man experiences himself in time-critical cybernetics when interacting with digital media. Micro-temporal events which govern human action can only the analyzed by non-human instruments; they become crucial in neuro-biology: "Many phenomena recorded from brain structures such as the EEG (electro-encephalogram) [...] are expressible as characteristic temporal activity patterns; their forms, however, mainly come from the recording method."[225]

The temporal momentum in technical (micro-)infrastructures

The temporal constellation which has replaced the narrative time series unfolding between beginning and end, in human-computer interaction, is the mode of *interrupt*. Hereby, *kairotic* time replaces *chronos*. Such interactive events between computer and human unfold rather algorhythmically than rhythmically as familiar from traditional culture, coupled to the steps which unfold within the computer itself, where instruction-execution tables express an ordering of inner events.

A time-critically sharpened reading of McLuhan's "medium is the message theorem" leads to a focused inquiry of the temporal momentum in technologies. This does not only concern the macrotemporal *bias of communication* in the sense of Harold Innis' media theory of cultural and economic power infrastructures, but the intensive microtemporality that pervades signal transduction in electronic circuitry and data processing in Integrated Circuits - the drama of literally hard-wired temporalities within microchips which, as "embedded" or "ubiquitous" computing, are the elements of a topological (more precisely than traditionally "infrastructual") web of computational forces.

In a very different way, the temporal message of digital communication media is in temporal deferal: from *live on tape* to media content *on demand*. This is the temporal signature of webcasting different from broadcasting media like radio and television.[226] This time-critical souvereignty and immediacy in access leads to a "tactilization", in fact: an almost *haptic* access to media time (to use

224 See Claus Pias, Computer-Spiel-Welten, Munich (sequenzia) 2002
225 Teuvo Kohonen, Self-Organization and Associative Memory, Berlin / Heidelberg / New York / Tokyo 1984, 90f
226 See Andreas Bade, Das Internet als programmbegleitendes Medium des Hörfunks. Historische Entwicklung von Internet, Radio und ihrer Medientheorien, Hamburg (Diplomica Verlag) 2009, esp. 57-86, *online* http://www.mediaculture-online.de

one of McLuhan's terms for describing electroic communication). The clear distinction between what is present and what is past, what is transmitted "live" and what comes out of the archive, disappears. Some online-services of radio or TV channels offer access to commentaries on current news, while at the same time offering access to other commentaries on previous occasions. The delineations of the archive to the present become diffuse, almost fuzzy.

Technical *Eigenzeit* (the temporal logic inherent to media) shapes the collective perception of time; time itself looses its individual character. The study of time critically challenges media studies.[227] What, in this sense, is the message of Internet-based communication? The dominant communication platform of today, the World Wide Web, needs to be analysed on its operative level of temporal processualities and eventalities.

From time-based narrative to time-critical action

Whereas narrative once was the dominant art of time, symbolically dramatised time orders are now being reorganized by technologies.[228] Walter Benjamin 1936, in his essay *Der Erzähler*, states that experience, when cut of from epic tradition, can not be communicated any more in a narrative way. When heterogeneously juxtaposed, information has to be consumed at once - whereas narrative is extensive interpretation.[229]. Real time analysis belongs to computing and signal processing and is not narratable any more, subject(ed) to the instant. Henri Bergson insisted on human perception of durable time (conscience) as against chrono-photographical registering of temporal processes.

Story-telling is not an anthropological *a priori*. The traditional diegetic adaption of time-processing in the form of story-telling has become an anachronism itself with time-critical electronic and digital media; since the phonograph and cinematography, the essence of technical media is time-axis manipulation. In digital topographies, emphatic notions of time turn into a function of arithmetical micro-timing, since algorithmic media operate radically time-critical; time here becomes the decisive factor. In this radically temporalised culture, speed becomes crucial not only in computer games but as well in virtual war and economy ("high frequency trading"). When communication goes online, the culturally familiar mode of story-telling is replaced by variable configurations of time and non-predictable actuality - enumeration instead of stories. Taken to its extreme, this hypertemporality becomes somewhat arbitrary.

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227 "Zeit ist damit auch die Herausforderung einer Medienwissenschaft": Stefan Rieger, Kybernetische Anthropologie. Eine Geschichte der Virtualität, Frankfurt/M. (Suhrkamp) 2003, 143
228 Paul Virilio, Technik und Fragmentierung, in: Karlheinz Barck u. a. (ed.), Aisthesis. Wahrnehmung heute, Leipzig (Reclam) 1990, 71-82 (71). See as well Dieter Thomä, Zeit, Erzählung, Neue Medien, in: Mike Sandbothe / Walther Ch. Zimmerli (ed.), Zeit - Medien - Wahrnehmung, Darmstadt (Wiss. Buchges.) 1994, 89-110
229 See Walter Benjamin, Der Erzähler, in: idem, Gesammelte Schriften, Frankfurt/M. 1972 ff., vol. II.2, 439ff

Archival storage becoming time-critical technical memory

Traditionally being part of symbolic suspension from time (called memory) and itself being an agency of storage, even the archive and archival usage become time-critical. From a media-archeological point of view, the traditional archive gets deconstructed by the implications of digital techniques. Since antiquity and the Renaissance, mnemotechnical storage has linked memory to space. But nowadays the static residential archive as permanent storage is being replaced by dynamic temporal storage, the time-based archive as a topological place of permanent data transfer. The archive transforms from storage-space to storage-time. Classical archival memory has never been interactive, whereas documents in networked space become time-critical to user feed-back.

In electronic media, the classical practice of quasi-eternal storage is being replaced by dynamical movements "on the fly" as a new quality. Memory is technically defined as "a device into which information can be introduced and then extracted at a considerably later time"[230] - close to what is known as a buffer in electronics. Minimal delay memories are at work in time-based and time-critical media even the more if we do not notice them. Drastically, these binary micro-memories dissimulate apparent "live" transmission by calculation in *real time*. In the development of one of the first full-electronic digital computers, the *Whirlwind* project for the US Air Force under the direction of Forrester soon after World War II, the solving of the data storage problem proved to be the crucial one, since high-speed data processing (necessary for real time interaction as intended with the *Whirlwind*) is often slowed down by the bottle-neck of intermediary data storage. The mercury delay line which was one of the alternatives proved to be too slow since it it based on electro-acoustic transduction. It finally took the electrostatic storage tubes (familiar with the TV tube) to address and store data with almost the proverbal speed of light itself. "The incorporation of the storage element depended upon the progress of the storage-tube-research and development [...] especially after parallel transmission of digits had been decided upon [...]."[231] Time-criticality here refers to both the external (techno-contextual) and the internal (techno-imminent) sphere.[232] But writing this as a "history" itself dissimulates the time-criticality by submerging and suspending it within an overall narrative coherence. Time-criticality (which is about discontinuous moments) is better

230 Glossary, in: Edward B. Magrab / Donald S. Blomquist, The Measurement of Time-Varying Phenomena, New York et al. (Wiley) 1971, 314

231 Kent C. Redmont / Thomas M. Smith, Project Whirlwind. The History of a Pioneer Computer, Bedford, Mass. (Digital Press) 1980, 180

232 On immanence in technical evolution, see Gilbert Simondon, Du Mode d'Existence des Objets Techniques, Paris (Aubier) 1958, chap. I "Genèse de l'objet technique: le processus de concrétisation", 19-49 (esp. on the thermionic tube); translation into English (Ninian Mellamphy): On the Mode of Existence of Technical Objects, London (University of Western Ontario) 1980; *online* http://accursedshare.blogspot.com/2007/11/gilbert-simondon-on-mode-of-existence.html

revealed by media-archaeographical analysis and diagramatic representation. Software is a new kind of cultural artefact: not a material object any more, rather an executable file which unfolds only when being processed - a truly processual time-object. A computer as hardware can be traditionally displayed as an immobile object, but its „bit-critical" processes are never in *stasis*, just like frequency-based acoustics (sonic evidence) needs performance in time to take place - different from visual images which persist in space. Contemporary time-criticsm thus focuses on technomathematically implemented algorithms.

Focus on micro-temporality

The conceptual focus on micro-temporality within and inbetween the ICs of microprocessors identifies data storage and processing as an active process, not simply as archival *stasis*. Already the electronic image from analog video tape had continuously to be refreshed, just like the line and frame update frequency in digital imaging. Only due to physiologically slow human perception it appears as a stable image - which makes all the difference between media archaeology and phenomenology. The turingmachine itself is a step-wise, time-discrete reconfiguration of machine states, but in its technological escalations the motion and dynamics of the hard drive became ultraspeed. The micro-infrastructures of "digital memory" in the von-Neumann architecture of computing can not be reduced to its Read Only Memory chips but requires constant regeneration from Random Access Memory technologies from the early ultra-sonic mercury delay lines, the Williams tube, and rotating magnetic cylinders onwards.

Concerning the essentially binary operations of numerical computing which extend to "big data" processing in the Digital Humanities, translating every "wordly" physical signals into voltages which count as numbers (the essential effect of A / D conversion in the sample-and-hold mechanis) results in an ahistorical short circuit between the digital present and the ancient Pythagorean mathematical world order, kind of Moebius looped resursion. While this is apparent on the level of the symbolical order, the difference is in its physical implementations (and resulting frictions[233]), Here, taking into account time-criticality and micro-temporality of data-processing matter makes all the difference that defines the algorithmicized present.

Time-criticality of computing and computing (with) time

According to Martin Heidegger's *Sein und Zeit* (1927), it is the awareness of death which inscribes a temporal vector into the human sense of being, as a phenomenologically deferred *futurum exactum*. This pattern escalates dramatically within electronic media, turning Heidegger's question from an ontological one into an analysis of micro-temporalities which take place there, critically. The mechanical clock already, with its mechanical "escapement", literally has a sense of the vantage point (the flight) of time. Heidegger's

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233 As discussed in Morton Riis, Machine Music. A Media Archaeological Excavation, Aarhus 2012; PhD dissertation at The Royal Academy of Music, Aarhus Department of Aesthetics and Communication, Aarhus University, 72 f.

ontological archaeology of temporality within human being stays decisively anthropocentric, explicitly opposed to reified time as embodied in a trivial machine: the mechanical clock. But with the cultural mastering of electro-magnetism (electronics) a form of processing temporal moments came into the world which unfolds a temporal *kosmos* of its own, its very own chronosphere which needs (analogous to Heidegger's analysis) an analysis of its media-*arché* which does no derive origins but re-veals groundings, uncovering the eventuality, which is: temporality and finiteness of being. Media archaeology performs this time-critically, on the micro-temporal level of electrophysical media.

In mathematics, Newton and Leibniz have developed a mighty tool known now as differential and integral calculation in order to cope - for the first time in occidental intellectual history - with temporal objects, notably speed and acceleration. Analogue computing has such a sense of physical time, different from numerical computing. Numerical mathematics rather constructs discrete algorithms to cope with continual mathematical problems in two ways: direct computing which after a finite temporal process delivers the exact solution, and approximation. Digital clocks in the technical sense do not drive indented wheels any more, but count by numbers. It was Aristotle, who in book IV of his *Physics* has defined time as a function of numerical measuring a movement. Heidegger opposed „vulgar" mechanical time - as objectified in the ticking clock - by „essential" time.[234] Countable time is a form of periodic measuring.

What separates the actual electronic computer from the Turing model as a literal "paper machine" is its implementation into not just symbolic, but physical operativity, that is: the speed of electron(ic)s. According to Moore's Law, not only the density but as well the speed of semiconductors in micro-chips doubles more or less every 18 month. The temporal *punctum* becomes decisive in electronic computing: "The *interval* is where the action *is*"[235]; unwillingly, McLuhan here graps the essence of binary data processing - the temporal gap in switching between Zero and One. It was the god-father of cybernetics Norbert Wiener who - remarkably within the discussion of analog *versus* digital computing during the New York "Macy conferences" coined the term "time of non-reality" for the switching time between zero and one.[236] The way digital computers *draw a distinction* (alluding to Spencer-Browne) itself is not simply a logical discrimination but takes a micro-temporal switching within flip-flop circuits. Like the signifier in structural linguistics (de Saussure's phonemes) is nothing by its own and is defined only by its differential oppositions, the difference is not geometrical, but a *différance* in Derrida's sense, that is: an act of temporal deferment. Even if this moment ideally tends towards the Dirac impulse (a *punctum* with ultimate amplitude but no temporal

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234 Heidegger 1927, § 81

235 Marshall McLuhan, Letter to Barbara Ward, 9 February, 1973, in: Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford University Press) 1987, 466

236 See Claus Pias (ed.), Cybernetics - Kybernetik. The Macy Conferences 1946-1953, vol. 1: Transactions / Protokolle, Zürich / Berlin (diaphanes) 2003, 158f

extension), it will always - once the logic design is implemented into physical matter - take its temporal delay *delta-t* which is time-critical when it comes to computing time. Different from pure mathematical symbol notation on paper, techno-mathematicality is physically operative, that is: within the time-critical regime.

It is significantly in a publication entitled *Faster than Thought* that the reason for the success of early vacuum-tubes based computers over electro-mechanical machines is being explained: "All the operations [...] carried out by these valves could equally well be achieved by the use of ordinary switches and variable resistances, but for one thing - time. Valves can be switched on and off almost instantaneously."[237] Still, any logical or numerical switching of discrete information consume a minimal interval of time with which it literally has to count. Even quantum mechanics implies the discrete behaviour of physical nature in regard to available energies and time; the switching of a single quantum information bit requires a minimum amount of time. According to the Margolus-Levitin theorem, switching time is inversely proportional to the energy expended.[238] At that moment, "time" emancipates from all metaphysical transcendence and is treated as an operator. Functional timing, not "time" is subject and object of media tempor(e)ality.

SUSPENDING THE "TIME DOMAIN". Technological tempor(e)alities of media infrastructures

The non-human temporality of technological knowledge

In favor of a diagrammatic definition of technological media, media archaeology is concerned not only with their structural "hardwired" level but with their *operative* unfolding-in-time as well. This vector places it close to signal analysis. Any media event is a time function of signals.[239] In addition, the radical media archaeology of the present media-infrastructural condition requires analysis of its mathematical, algorithmic operations.

Such an understanding of techno-temporalities does not focus on phenomenal effects of media on humans but primarily refers to the microregimes *within* technological devices. Complementary to discourse analysis, it listens to the implicit epistemic articulations and enunciations of infra-technical operations. In that sense, "hardwired temporality" does not simply refer to the infrastructuring of time by technologies is concerned with the temporal structure as revealed from within techno-logical knowledge itself. From that arises an epistemology of technical processuality beyond the conventional notion of "time".

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237 B. V. Bowden (ed.), Faster Than Thought. A Symposium on Digital Computing Machines, London (Pitman Publishing) 1953; here quoted from the paperback edition 1971, 42
238 See Seth Lloyd, Computational capacity of the universe, in: Physical Review Letters, vol. 88 (2002)
239 "Zeitfunktionen der Signale": Karl Küpfmüller, Die Systemtheorie der elektrischen Nachrichtenübertragung, Stuttgart (Hirzel) 1974, 393

The anonymous time-base of modernity: Clocking

In present information society (for which the Actor-Network-Theory admits non-human members), its time-base turns out as a critical focus of analysis. High frequency trading as data exchange, in the electronic stock market as well as in the communication sphere (the "Internet"), surprisingly recalls late medieval monasteries. A true media archaeology of technically temporalized infrastructures starts here and not in the short memory of the recent present. Benedictine monks which needed periodically exact clocking for prayers according to their monastic rules invented the escapement-driven wheeled clock.[240] The regular oscillation, subdividing movement into equal quanta, is a precondition not only for industrial production but "social media" communication as well. Within the von-Neuman architecture of current computers, the heart-beat of the time base enables exact synchronization of cycling units in data processing.

The escapement-driven clock, though, has been invented anonymously.[241] Such temporality can not be reduced to the timeline of cultural history but rather finds "itself". There is a rather non-human temporality at work in the infrastructuring of techno-logical knowledge.

According to Heidegger, long before computing in the strict sense, information society already started with the modern *Weltbild*: with the measuring and numerical (scientific) approach to physical nature. An archaeology of the contemporary therefore starts with what in German is appropriately called "Neuzeit" in a double sense, since the new epoque starts with the mechanical clock itself. Marshall McLuhan, in media-epistemological terms, *recedes* even further below the clock technology, to the "technologizing" of the spoken word[242] by the ancient Greek vocal alphabet itself. It has been alphabetic writing which cognitively induced the analysis and synthesis of oral speech flow into discrete, digital units. Only when the letter (reduced to the max as binary information unit) is radically meaningless in itself, it enables all kind of storage, transfer and symbol manipulation (processing) of meaning. Once more, it is epistemologically remarkable that there is no way to inscribe this cultural technique on the historic timeline, since there is neither a precise date nor a known inventor.[243] Technological culture takes place in anonymous temporality.

The non-sense of "time" for technological analysis

240See W. E., Ticking Clock, Vibrating String: How Time Sense Oscillates Between Religion and Machine, in: Jeremy Stolow (ed.), Deus In Machina: Religion, Technology, and the Things in Between, New York (Fordham University Press) 2013, 43-60

241 See Gerhard Dohrn-van Rossum, History of the Hour, Chicago (University of Chicago Press) 1996

242 Walter Ong, The Technologizing of the Word, London 1982

243 See Barry Powell, Homer and the Origin of the Greek Alphabet, Cambridge (UP) 1991

Technological media knows processual realities but not "time"; therefore the neographism "tempor(e)alities" is preferred in the subsequent argument which unfolds such media tempor(e)alities on three levels: first of all within technologies, when the micro-timing of signal transduction is crucial for the event to succeed at all; next there are phenomal affects and irritations induced by media events on the human sense of temporal experience; finally "deep" media temporality (logic and machine) turns out to be rather autonomous from the cultural imaginary of imaginary time aka "history".[244]

In that context, the very notion of *hardwired temporality* is a relief. Its ambition is not deep philosophical questioning of the nature of time; *temporality* is rather a term which names a couple of signal functions like the Delta-t, functions of signal processualities like transfer or delay, even storage. For the close analysis of contemporary media technologies, the *arché* is not in "time", but a cooriginality where "time" is suspended. Media archaeology is "radical" in the sense that it looks for roots not in "time" but in the technological event. There can be no infrastucturing of temporal orders but only infrastructures triggering notions of "time" as secondary effect. Here, the notion of time as *a priori* condition for perception (as defined by Immanuel Kant) does not count. If time counts here, it is in the precise sense of clocking which generates what Martin Heidegger denounced as "vulgar" technical time. In that sense, technical infrastructures are not "time"-based, but "time-basing". What has been decisive for digital computing in the singular machine, the more counts for interconnected computers. Communication is infrastructured not only materially by hardwired cables, antennas and data processing devices, and in the symbolical order by protocols and codes, but temporally infra-structured. Synchronization of internet traffic creates an artefactual tempor(e)ality, just like the introduction of a synchronizing master clock has been the condition of being for the impression of a universal "time" in nineteenth century. The master clock, in networked computing and communication, has imploded into a myriad of local temporal agencies. This temporal pattern is multiple and invites to replace transcendent signifiers like "time" by a plurality of more precise *termini technici*, practicing a language of analysis which by-passes outdated notions like "time" in the mediasphere.

Walter Benjamin defined the nineteenth century as the antiquity of the "now". Back to 1839, we are already in the actual "present" indeed, when Karl August Steinheil designed a time-keeping system for the synchronization of electro-magnetic external clocks which get their time impulse by a mechanical central clock whose pendulum triggers alternating positive and negative poled "time impulses" - an interlacing of time-keeping and telegraphy. Today, the radio time signal transmitter DCF77 (77,6 kHz) at Mainflingen synchronizes radio clocks wireless.

In a radically media-archaeological understanding, techno-logical infrastructures extend from material (technical) to mathematical (logical) grids, to the algorithms embedded within ubiquitous microchips. The imaginary unifying time axis is decomposed into a symbolic concatenation of programmed processes, patterned and interrupted by moments of the

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244 See W. E., Chronopoetics. The Temporal Being and Operativity of Technological Media (2016)

tempoReal. Aristotle has been radically media-archaeological in book IV of his *Physics,* defining "time" as resulting from measuring movement sequentially by numbers. Even etymologically, only from incisive cuts the notion of a temporal order arises.

Functional timing in technology: synchronization

Rigid analysis of technology does not know metaphysical "time" but rather an ensemble of temporal operators. There is no given pre-existing "time" but rather an enforced timing, as expressed in the very constructive term of synchronization.

Edmund Husserls once phenomenologically described as mechanism of the inner sense of subjective time. Such a temporal horizon unfolding as extended present between re- and protention is radically "grounded" and de-metaphysicized when it comes to technological ensembles. Lewis Fry Richardson's once designed a (human) computing "forecast-factory" for real-time calculation of weather[245], connected to local weather stations in telegraphic "instantaneity". A central official maintains "a uniform speed of progress" for the individual partial calculations, "like the conductor of an orchestra in which the intruments are slide-rules and calculating machines" (ibid.). Pantoptically, "he turns a beam of rosy light upon any region that is running ahead of the rest, and a beam of clue light upon those who are behindhand" (ibid.).

In the meantime, human synchronization of human "computers" has been replaced by the cybernetic diagram of feedback circuits, replacing the central time control agency by a flexible automation where human monitoring itself becomes integrated into the circuitry. For a moment, technological utopia has become reality: the "Opsroom" for monitoring & control in Stafford Beer's Cybersyn computing structure in Salvador Allende's Chile 1971-73 for national feedback and control of economic data from state-owned factories. The data flow was based on a "Cybernet" teletype network, to be calculated by a central mainframe IBM 360 computer Cyberstride, and monitored by a collective of humans for positive or negative feedback. Human wetware is wired into the symbolic infrastructure for the option to interrupt and correct: suspending the time series generated by data.[246] The melodic re- and protentional "inner time consciousness" of the human individual (Husserl) is replaced by a radically "discrete" attitude which is the temporality of counting.

The emancipation of technical timing from natural "time"

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245 Lewis Fry Richardson, A Forecast-Factory, in: ders., Meteorology and numerical analysis, Cambridge / New York (Cambridge University Press) 1993, 219
246See Manuela Garretón / Diego Gómez Venegas, Towards an Archaeology of Media and Visual Languages, in: FabLab Santiago (ed.), The Counterculture Room. Pavillion of Chile at the London design biennale 2016, Barcelona (Ediciones Poligrafa) 2016, 108-127

Media culture is not shaped by a transcendent timeline but technologies themselves "shape" time (George Kubler). In the 1930s, the crystal quartz clock emancipated the timebase of technology from the astronomical "natural" reference - an epistemological break point. Within microprocessors, the timer chip 555 (IC) makes sense to the clock signals derived from the oscillating quartz within the computer main board.

Against phenomenological suggestions of endurance, a truly archaeological analysis of temporality is time-discrete. This imperative conditions the rhythmic bias of digital culture. As once expressed by Alan Turing himself, clocking is still the heart beat of structuring data processing from within.[247]

Against its meaning at first sight, "real-time" data processing is not about close to time but its actual negation. It replaces the familiar "live" signal transmission by a re- and protentional micro-time window of the present; telepresence (Heideggerean "Ent-fernung") becomes predictive coding, a mathematical *inbetween* of man and its physical environment.

Since 1970, UNIX-Time for operating systems and file formats in computers has been a system for describing instants in time, defined as the number of seconds that have elapsed since 00:00:00 Coordinated Universal Time (UTC), Thursday, 1 January 1970, not counting leap seconds. Because it does not handle leap seconds, it is neither a linear representation of time nor a true representation of UTC.[248] The *epoch* of the computational present starts here.

Since Unix version 6, Unix time counts seconds which have passed since 1st January 1970 00:00 o'clock UTC. This starting date is appropriately called "The Epoch". The Linux and Unix operating system subdivides the day exactly in 86400 Sec. But this chronotechnical regime does not itself tolerate for the interpolation of a leap-second according to atomic clock generated time keeping. A leap second is "occasionally adding a second to the Coordinated Univeral Time (UTC) system, familiar from current use to set our watches by radio signal transmission. Linus Torvald himself argued in favor of such time-critical syncopic interpolations in open computing systems as domain of the current techno-political regime.[249]

Occasionally, when computers have been forced to use the leap-second friendly UTC, such ruptures of the tempoReal crashed websites and confused airline departures. As well in 1999/2000, the Millenium Bug reminded that time within digital computers is logical, mathematical, not intuitive ("Bergsonean") time; counting dates is limited by the capacity of processor registers.

The tempor(e)ality of "online" timing actually escapes the historiographical timeline. Accurate timekeeping systems such as the atom-caesium clock embedded in GPS signal traffic are rather independent.

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247 Alan Turing, Lecture to the Mathematical Society on 20 February 1947, in: B. E. Carpenter / R. W. Doran (eds.), A. M. Turing's ACE Report of 1946 and Other Papers, Cambridge, Mass. (MIT Press) 1986, 111
248 https://en.wikipedia.org/wiki/Unix_time; accessed November 3, 2016
249 See http://www.wired.com/2015/01/torvalds_leapsecond/?mbid=social_fb

In computing science, the so-called "realtime" or the "physical" clock (as hardware) measuring physical time, differs from the logical clock (which is software); this causes the necessity to synchronize, in intervals, the realtime clock in computers with external time, by requesting time from *time servers* and then, by intelligent algorithms, equal the time delay in the Network Time Protocol NTP, based on IP Protocol and "Time Synchronization software.[250]

In October 1998, Swiss wachtmaker Swatch announced "Internet Time" which undoes the familiar differential time zones. Every day is devided into 1000 "beats", creating a new meridian in Biel, home of Swatch itself: the Biel Mean Time (BMT) as universal reference to InternetTime[251]. This is "an indifferent time, no longer the vectorial time of chronology"[252]. At that point, the familar historic *timeline* graph fails.

The fuzzy present of Internet communication

Jack Goody once defined cultural tradition in implicitely technological terms as "delayed transfer". Media archaeology applies such terms from emphatic temporality to the analysis of the micro-temporal field unfolding within communication infrastructures. Any media archaeological analysis of technological communication infrastructures takes their increasingly time-critical nature into account. If "time" is not understood in a unifying metaphysical sense but in its Aristeotelean definition, it turns out as a functional plurality of signifying incisions and intervals.

What has once been electro-magnetic "live" radio or TV signal transmission in tele-communication, has been replaced by "real time" computation which dissimulates the belatedness of complex calculations of discrete pulse trains, in order to trap the human perception of the "present". In digital *online* communication, there is no transmission *in* time but a timing of data packets (datagrams) which are numerically time-stamped to avoid traffic congestion in the Internet.

In 1972, Bob Metcalfe developed a programm for computer networking (the Ethernet) named PING, for testing its inter-operability. A connection through the physical and logical network topology is opened in order to test if the addressee actually reacts at all. From that technical implementatin of a time-critical test, Vint Cerf developed the Transmission Control Protocol for the Arpanet in 1975, which precedes the actual Internet. So-called time-to-live and ping-to-death are articulations of Internet temporality. The past is not "imperfect" any more, but becomes "historical perfect", residually enduring within the present. The "residual" is still active, "not at all as an element of the past, but as an effective element of the present."[253]

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250 See http://de.wikipedia.org, entry "Echtzeituhr"

251 See Geert Lovink, Net.Times, Not Swatch Time: 21st-Century Global Time Wars, in: same author, Dark fiber: tracking critical internet culture, Cambridge, Mass. (M. I. T.) 2002, 142-159 (152)

252 Loovink 2002: 143

253 Raymond Williams, Marxism and Literature, New York (Oxford University Press) 1977, 122. See Shannon Mattern, Deep Time of Media Infrastructure, in:

Metaphors like "streaming media" are misleading in their suggestion of a temporal flow. Even with respect to the signal carrier (the "flow" of electricity) information depends on the digitally coded electrons. Where humans believe to communicate messages via digital channels, there is a non-human temporality at work: computer-to-computer-connectivities. Any political criticism of the micro-physics of power has to focus on the time-critical eventalities on the most physical level of the OSI network model.

Network culture is less about modernist clock time but more about latencies. The delayed present stems from the "hyperbolic temporalities of digitality"[254]. Speculative media theory asks experimental questions: What if data packets were humans, how (if at all) they experience time?[255] In Web 2.0 packet switching, before any kind of "social memory" is triggered, intermediary storage is a decisive and integral part of the technical transmission itself. The age-old contradiction between archive and transmission collapses in the delayed present. Before there can be any moments of short-time virtual communities ("crowds", or even societies), data networks consist of distributed sparks of ultra-short retentions and protentions.

Time-to-live and ping-to-death: Internet temporality

In times of Internet protocols McLuhan's thesis that the pace of electronic media changes the patterns of temporal perception requires a somewhat closer reading. What he has described metaphorially has become literally true. Time-critical processes take place in its most media-archaeological sense, that is: on the basic layer of bit transfer in the, the *physical layer*. This layer represents the interface of symbolic transfer to the material (or electro-magnetic) channel of communication (such as copper cables, wireless directions, light waves lines) and thus embodies very concretely the interlacing of logi(sti)cs and matter which is already implied in the term "technology". It is on this layer that the voltage level of what is meant to represent a logic "zero" and a logic "one" is being defined. The function of this bit transfer layer is in the transformation of signals within a physical transfer channel into information in order to be passed further to level two of the OSI system.[256] This identification of signals happens within the time-critical field, such as signal frequency and signal duration, sychronous or asynchronous clocking, and the decision on serial or parallel data transfer.

In communication networks, topological systems are being appropriately

Lisa Parks / Nicole Starosielski (eds.), Signal Traffic. Critical Studies of Media Infrastructures, Urbana / Chicago / Springfield (Univ. of Illinois Pr.) 2015, 71-93
254 As stated in a lecture by Jussi Parikka (Winchester School of Art), Of Queues and Traffic: Network Microtemporealities, on occasion of the symposium *Digital / social media and memory*, University of Glasgow, April 17th, 2013
255 Parikka ibid.
256 Christoph Neubert, Elektronische Adressenordnung, in: Stefan Andriopoulos et al. (ed.), Die Adresse des Mediums, Köln (DuMont) 2001, 34-63 (41)

expressed by hypertextual links, whereas time-critical processes rarely become apparent. The answer to this is the finding of a new term which does not nominate a new medium but declares the temporal mode of a mode its decisive media-theoretical criterium. "The real-time web is a set of technologies and practices which enable users to receive information as soon as it is published [...], rather than requiring that they or their software check a source periodically for updates."[257] The communicative practice of *instant messaging* belongs to this temporal field; im McLuhan's sense the message of the medium here is immediacy serving to create the illusion of a pseudo-copresence. This recent form of web economy is being defined by communication within the time-critical realm; cyber*space* as "docuverse" (Ted Nelson) is being replaced by an extremely speed-up information processing in cyber*time*.[258] The Internet thus turns out not to be just a topological extension of a generalized archive, but equally as a chrono-technical expression of time.

To reveal the time-critical *message* of the Internet use, a close look at time-critical operations on the physical and logistical level of the Internet is required, such as the "Ping" signal. Each data packet into which a document has been sliced is being observed individually; its transfer happens independent from its preceeding or successive packages. This procedure is radically time-critical since is takes place within the so-called Time To Live-field which defines the maximal temporal duration in seconds an IP packet is allowed to exist in the Internet. A counter is progressively being reduced during this routing; in case the TTL-counter reaches zero before the packet has reached its destination, it is being annihilated.[259] Media time is not endless. In TCP/IP as fundamental network program, techniques of synchronisation meet a deadly economy of time. "Time to live" means that each data packet is assigned a given life span; "time to die" thus becomes a crucial signature of the information age.

While Husserl's phenomenology expresses neuro-cognitive perception of the present in "time diagrams" inbetween retention and protention, media archaeology tries to precisely identify the rather different operations of micro-technical signal transduction and algorithmic data processing. Humans and machines are different in their operative signal processing, resulting in different tempor(e)alities.

(A)Temporalizing radio: infrastructures in wireless communication

The present can be analyzed only when it just starts to recede into the past. The concept of a "pre"history of the present technological condition does not only refer to a "before" in its temporally sequential, historical sense, but to its technological pre-conditions as well. This pre-structuring "before" endures or re(oc)curs in the present in non-linear modes. Media archaeological analysis,

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257 http://en.wikipedia.org/wiki/Real-time_web (Stand: 20. Januar 2010)
258 "Früher ging es um die Schaffung von Räumen [...], heute geht es um die Zeit selbst, um Chronos, um die Kunst der *longue durée*": Geert Lovink, Was uns wirklich krank macht, in: Frankfurter Allgemeine Zeitung No 140, 21st June 2010, 27 (referring to the media theory of Franco Bernardi)
259 Othmar Kyas, Internet: Zugang, Utilities, Nutzung, Bergheim (DATACOM) 1994, 65

besides its apparent meaning of "origins" in the past, refers to a structural argument: the *arché* which is the insisting, essential features of a technological system. Heuristically, this means analytic reduction to the essential functions, the elementary bits, a rarefication against discursive redundancies.

All of the sudden, the "recent" is not past but a concealed retreat, the hidden, still co-present ground behind the apparent visible. The technological conditions takes place in intervals (*epoché*) where an established infrastructure remains valid across all apparent political, historical and cultural changes, like analog AM radio has endured almost technologically invariant for more than 80 years. Such intervals, as Delta-*t*, endure anachronistically (even achronically) when compared with the historical timeline. Public radio, in Germany, dates back to October 1923. As an independent media format, based in autonomous technological implementation, it apparently dies these years in its familiar AM / FM analog technology. A historic "timeline" representation of the heroic radio age is misleading. There is a re-entry of "radio" within mobile communication, not as program format and "broadcasting", but in its purest form as technical medium: wireless (German "Funk") electro-magnetic waves, this time: digitally modulated (mobile telephony, W-LAN internet access). In present mobile communication, there is more radio than ever, even if dissimulated as condition of possibility.

The infrastructure of Wired and Wireless Networks increasingly becomes interlaced. "Rather than wireless cities of wirless networks, it might be more accurate to speak of the rewiring of cities through the highly reconfigurable paths of chipsets."[260] In wireless communication, the infrastructure has become mobile itself. For wireless transmission of analogue signals, electro-magnetic infrastructures have been described as a sphere, as "acoustic space" by Marshall McLuhan, since its inherent message (its implicit "sonicity") has been the wave as temporal form. "Electric speed is approximately the speed of light, and this constitutes an information environment that has basically an acoustic structure."[261] In digital communication, this almost Heideggerean "Being" of electro-magnetic space[262] has been inverted from melodic tuning to pulsed rhythm. Eleni Ikoniadou's *The Rhythmic Event* (MIT press) conceptualizes digital events not as binary sequences of zeros and ones but instead as relational pulsation. This correlates with the notion of "algorhythmics" - the rhythmic processes of computational algorithms.[263] In that sense, hard-wired temporalities can never be reduced to (infra-)structures, but in reverse, they temporalize such structuring conditions (*l'archive*, in the sense given by Foucault's *Archéologie de Savoir*) themselves, "posting" infrastructures.

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260 David Mackenzie, Wirelessness. Radical Empiricism in Network Cultures, Cambridge, Mass. / London (MIT Press) 2010, 65
261 Letter to Barbara Ward, 9 February, 1973. McLuhan 1987: 466
262See Rainer Bayreuther, "Phänomenologische Grundlegung" einer Disziplin, in: Heidegger-Handbuch: Leben - Werk - Wirkung, ed. Dieter Thomä, Katrin Meyer, Hans Bernhard Schmid, chapter 2.2 "Auf dem Weg zu einer Akustik des Seyns": 'Stimmung', 'Schwingung', und 'Harmonie' nach Sein und Zeit", Stuttgart / Weimar (Metzler) 2013, 509-512
263 Shintaro Miyazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012 (http://computationalculture.net)

While the data processing microchips themselves are still hardwired infrastructures in themselves, the wireless signal transfer has become a dynamic infrastructure consisting of extremely volatile temporal objects: multiple radio-frequency waves, which are transduced in Digital Signal Processing devices embedded within mobile phones and other wireless communication devices. In order to exhaust the available channels for signal transmission in parallel (known from George Antheil and Hedy Lamarr's invention of "frequency hopping"), "[t]he designers of contemporary wireles DSP chipsets usually supply a palette of different hardwired algorithms alongside generic processors."[264] Just as in Integrated Circits, the integration of hardwired and wireless networks allows for algorithms to operate. Radical mathematization transforms conventional communication engineering into intelligence in its double meaning.[265] While most of the physical layer of information networks "is quasi-hardwired into semiconductor chips"[266], in order to facilitate algorithmic intelligence (or "cognitive radio") to unfold its micro-timecritical efficiency, its dynamic intra-structure is not "time"-based anymore in the ontological sense but an asynchronous grid of operative temporal actions like compressing movements into ultra-short slots. Such a mobile network replaces the immobile cables of Internet or telephone lines by a dynamic, in fact temporal grid for time-critical signal processing. Wireless communication is not simply a form of bridging spatial distances by electro-magnetic waves between antenna and receiver any more, but becomes primarily a function of intelligent shaping of signal events inbetween. The traditional linear medium channel becomes itself dynamical and temporalized, "synthesized by technical processes expressed in algorithms. These algorithms generate waveforms that support conjunctive pathways"[267] - that is, a mobile infrastructure, a new kind of ether. "Their interwoven texture creates an envelope that allows data to circulate in the crowded signal channels of urban-electronic space as if it were just noise."[268] Although this almost amorphous infrastructure is still grounded in conventional communication ingineering and technologies, in its essence it becomes more radically mathematized than even conceived by Shannon.[269] While the traditional radio wave has been a time signal, in digital processing it becomes decomposed in frequency values in order to be treated computationally. The time axis itself is techno-mathematically suspended when a waveform that varies over time is transsubstantiated into a set of component frequencies by Fourier transform; at the same time it allows for switching back from the frequency domain into the time domain. Such communication infrastructres oscillate between temporal and atemporal moments. Fourier transform is challenged by a structual incertitude either towards temporality or spatiality; in so-called wavelets, temporal linearity itself is suspended. For more

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[264] Mackenzie 2010: 72

[265] This becomes apparent from topics like "Algorithms and Modeling for Tracking and Locating Mobile Users" in the call for papers to the 10th International Conference on Wireless & Mobile Network (WiMo 2018), May 26-27, 2018, Vienna

[266] Mackenzie 2010: 70

[267] Mackenzie 2010: 67

[268] Mackenzie 2010: 70

[269] Claude E. Shannon / Warren Weaver, The Mathematical Theory of Communication, Urbana, Illinois (Univ. of Illinois Press) 1949

efficient transmission streams of digital signals themselves become superimposed and enclosed in a signal envelope that looks like white noise, which is finally filtered back into a data stream. Temporality is just one (itself "ephemeral") function within such chains of operations. Efficient coding (convolution) has been developed to match signal errors and erroneous signal intrusions: "The stochastic character of the Viterbi algorithm [...] alters the terrain on which machine time moves."[270] What has once been conceived as moments "in time" becomes a function of irruptions of the tempoReal (an escalation of Norbert Wiener's notorious term "time of non-reality" for the switching momentum between binary states[271]). Far beyond the world of communication engineering, knowledge culture has to acknowledge this non-symbolic temporal quality, learning from media.

Contemporary "media ecology" identified from within its temporal infrastructures

The often debated "technological determinism" in media analysis is infra-structual by necessity. This leads to a reconnaissance of both hardwired (materially embedded) and softwired (algorithmic) structures with govern media temporality from within. Media archaeology is a consciously *anachronistic* identification of con-temporary predefining states and layers of electronic media culture. The technological infrastructure of AM radio, for instance, endured for almost the whole 20th century, notwithstanding the political and cultural catastrophies occurring within that century. The endurance of insisting hardwired and softcoded technologistics creates a temporal interval of its own. As long as such an *epoché* is still in operation, its media are excepted from the transience of the historical event. Such a theory of media time does not only concern emphatic "deep temporality" on a grand scale, but inversively re(oc)curs within the microscale of techological timing in the concrete circuitry of electronics itself.

Current intellectual discourse in "speculative design" theory registers a current shift from progressive modernity to an *epoché* of contemporaneity where time is not an empty duration unaffected by the processes which happen within its technologies. On the extensive and micro-level of technological infrastructures, there is no homogeneous "time" but multiple and asynchronous tempor(e)alities, reminiscent of Ernst Bloch's notion of "non-contemporaneous contemporaneities" ("die Gleichzeitigkeit des Ungleichzeitigen"). The infrastructures of technological contemporaneity is not a coming together of data in time, but of functional timings.[272] Technological machine times challenge historicist notions of accumulative continuity. The concept of "media

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270 Mackenzie 2010: 80

271 See Claus Pias,Time of Non-Reality. Miszellen zum Thema Zeit und Auflösung, in: Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 267-279

272 See the Danish Research Fund project "The contemporary condition", University of Aarhus, 2015-2018, directed by Jacob Lund and Geoff Cox, and (related to this research project) W. E., The Delayed Present. Media-induced interventions into contempor(e)alities [*The Contemporary Condition* series], Berlin (Sternberg Press) 2017

ecology" in that sense refers to temporal environments, to being in a clocked world, Heidegger's "Zeit des Weltbilds" taken literally.

In media-archaeological terms, computational technologies, in the very essence of both components (*techné* as well as *lógos*), consists of *both* "hard-wired" temporality on the very infrastructual level of microchip circuitry, and of "soft-wired" temporalities resulting from what drives such machines: source code which concerns time-critial operations in computational languages such as Assembly. Micro-temporal physicality (the "real") is as much the object of media archaeological analysis as "the symbolic" ordering of signal series, the algorithmic logic of digital culture) - while the imaginary (*alias* "history") does not matter.

NON-HUMAN MEMORY, TECHNO-TRAUMATIC MEDIA TIME: On asymmetries between historical testimony and storage-based forms of re-presencing

Media testimony and the indexical trace: from analog to digital

There is not only asymmetries between historical testimony (which is related to human narrative and historiography) and technical recording, but as well between analog transduction and digital sampling of such testimony.

When human eye- and ear-witnessing is delegated to the technical apparatus in order to achieve "immediate" testimony, the anthropocentric notion of "memory" itself becomes metaphorical and needs to be replaced by its analysis as *bodyless recordings*. Not only does historical testimony change in that electronically mediated context; with digitization it risks to loose its historicity at all.

In his analysis of memory systems, Klaus Krippendorff differentiates between *memory involving records* which depend on (at least intermediary) fixation of records worth of remembrance and almost memoryless *reverberating circuits*. But in administration there is a third form of memory at work: *structual memory*.[273] The notion of such a functional memory, in times of media culture, needs to be extended to the technological condition itself, to its techno-archival infrastructure. Audio and video tapes are not simply carriers of recorded human testimony but *archiving* presence in non-human ways.

With increased technology-based contemporary witnessing, a different kind of testimony has arisen, de-coupling memory from the historical form. In that context recent trauma studies with their insistence on the non-historicized or even *non-historicisable* momenta of experience in human memory become vital not only in the psycho-analytic and desaster studies sense, but as an epistemological challenge. "Trauma" is that kind of shock in temporal experience which has not yet been (or can not be at all) digested by smooth memorization (*Er-Innerung*, in G. W. F. Hegel's terminology) and like a "transistor" (contracted from "transfer resistor") resists integration into historical discourse as the narrative ordering of sequential time.

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273 Klaus Krippendorf, Principles of Information Storage and Retrieval in Society, in: General Systems Bd. 20 (1975), 15–34

In that context, media archaeology as specific method of media studies does not try the re-mediate technical storage with human memory but radically acknowledges that fundamental difference, even if subtle interlacings arise in a second step of analysis. Technological storage is radically inhuman in its originary techno-temporality, somewhat autonomous from the historiographical or even cultural frame.

In a slight modification of Walter Benjamin's notorious term, the audio-visual electronic signal carries with it a "historical index": it waits to be technologically redeemed from its storage latency[274], just like after Henry Fox Talbot's invention of kalotype photography the negative waits to be developed into positive prints. What if the witnessing signals materialize into magnetic remanence on audio or video tape, waiting for re-play in electric induction? "Discourse analysis cannot be applied to sound archives or towers of film rolls"[275]; rather archaeological signal analysis by means of measuring media is required here. Popular music recordings like *Alan's Psychedelic Breakfast* by Pink Floyd, as a studio creation, start existing for a listener only when she or he puts the record on and presses Play. "Even if a recording has been released thirty years ago, it will stay out of our perceptual and temporal sphere until it will reach our ears and mind".[276] What if the recording technology itself becomes the witness?

Very soon after the first public appearance of cinematography, Boleslas Matuszewski proposed to create an archive of "living photography" recordings of "anecdotical" events, praising the technical impartiality against the idiosyncracies of personal testimony.[277] Since it is not yet hermeneutically filtered by the historical sense, technical recording - like the chronicles in ancient Rome and Medieval times - "recites events without distinguishing between major and minor ones [...].[278] Such cinematographic recordings were meant to be redemptive. "Nothing that has ever happened should be regarded as lost for memory.

In this respect, the creation of the Fortunoff Video Archive for Holocaust Testimonies at Yale University did not simply introduce a significant reconfiguration of the archival formation whereby the audiovisual takes the role of the textual; the symbolic regime of the archive which consists of scripture,

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274 Walter Benjamin, Theses on the Philosophy of History, in: same author, Illuminations. Translated by Harry Zohn, edited and with an Introduction by Hannah Arendt [1968], New York (Schocken Books) 2007, 253-264 (Thesis II, 254)

275 Friedrich Kittler, Gramophone – Film – Typrewriter, Stanford (Stanford UP) 1999, 5

276 José Van Dijck, Remembering Songs through Telling Stories: Pop Music as a Resource for Memory, in: Sound Souvenirs, Audio Technologies, Memory and Social Practices, Amsterdam University Press, Amsterdam 2009, 109

277 Boleslas Matuszewski, Eine neue Quelle für die Geschichte. Die Einrichtung einer Aufbewahrungsstätte für die historische Kinematographie (Paris 1898), transl. from French by Frank Kessler, in: montage av vol. 7, no. 2 / 1998, 6-12 (11, note 1)

278 Benjamin 1968/2007: 254 (Thesis III)

words, inventories is transformed into signal processing. "This reconfiguration entails a profoundly different concept of the archivable; the audiovisual archive is designed to store precisely that which cannot be properly archived by writing - trauma."[279] But next to this trauma-preservation as content of video recording there is an ongoing co-traumatizing effect of the recording technology as signifier in itself.

Of course a phonographic record is not human itself, neither is it the video tapes of Holocaust testimonies. But both kinds of signal still keep an indexical relation (in Charles S. Peirce's terms) to the human survivor. The wave forms of the recorded sound and image are based in the analog technology; this allows for the assumption of testimony being an anlog trace of what has happened. But what if such indexical auditive or visual recordings are being digitally sampled? Digital data are not bodyless themselves (they are still very physically implemented as voltage levels) but radically codify the recorded human body and replace the indexical affect by signal intelligence. Media archaeology therefore replaces Benjamin's hot theologial view with cold analysis.

"The 'born-analog' films persist as analog masters or 'originals' in the archives"[280], while their digital conversion de-couples them from this material link to the historical past in favor of the software present of today.

Media-archaeological analysis rather concentrates on the deep epistemological implications, than to the most obvious effect of digitization in audio-visual testimony archives which is its becoming "online" *via* the Internet. By their almost immediate accessability such records loose their archival authority which requires the user to personally turn up and authorize himself. "Online" memory has no *locus* any more. The new media-archival memory is an almost spectral superimposition of two technological conditions: electronic signal recording and its bit-coded informatization. Communication engineers will respond that according to the sampling theorem the authentic signal can be fully reconstructed (as long as the bandwidth is limited). But inbetween (and sublimely unnoticed by human perception), by its binary informatisation, the signal is subject to a complete "transsubstantiation" (in terms of Christian liturgy). Flesh becomes word again - in the sense of bit-streams. Since to human senses the difference between analog and digital media testimony might not even be noticable, it requires a different kind of epistemic (rather than simply visual) "insight" which makes us look at such digitized testimony with suspicion.

"Videotestimonies" in Holocaust memorization

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279 Amit Pinchevski, in: The Audiovisual Unconsciousness: Media and Trauma in the Video Archive for Holocaust Testimonies, in: Critical Inquiry, vol. 39, no. 1 (Autumn 2012), 142-166, 165
280 See Trond Lundemo, Digital Returns: the Archive of the Planet and the "Rhythm of Life", in: Kjetil Jakobsen (ed.), `The Cosmopolitics of Visual Memory: Albert Kahn's Archives de la Planète, Bristol (Intellect), conclusive remarks (forthcoming)`

Traumatic memory is most prominently associated with survivors of the Holocaust, which is progressively transformed into the symbolic order of narrative discourse, while media-archaeological perspective rather points to the entanglement of traumatic memory with the non-historical time sense of the involved technologies.

For the human audience of mediated testimonies, the co-traumatising irritations of memory do not come from the drama of the historical event exclusively, but more sublimely from the recording media themselves. The traumatic, that is: non-historicizable past is modulated by a fundamental technologically induced trauma. The principal agency of desaster memory still is the *human* capacity. With the passing of the still living generation such remembrance is delegated to non-human memory agencies such as institutional archives or technical audio and video recording. All of the sudden, a technological *eigenzeit* and its specific forms of temporalization start to determine this remembrance from performative (the human) to the operative (the technological).

The idea to videotape the testimonies of Holocaust survivors was initiated in 1979 by the television producer and psychiatrist Dori Laub. It soon took shape as the "Holocaust Survivors Film Project. "Despite the name, filming was conducted from the start in videotape."[281] When in 1981 the Fortunoff Video Archive for Holocaust Testimonies has been created, the original recording format was three-quarter-inch U-Matic videocassettes with a running time of one hour and seven minutes. Due to deterioration of the magnetic tape, the original videocassettes have been stored in a temperature-controlled room in the Yale archives which is a "secret" archive (if not *genizah*) of a new type. The video testimonies available for viewing at Yale have therefore been VHS copies of the originals.[282] This vulnerability of material signal carriers to physical entropy is counter-acted neg-entropically by digitization ("information" in terms of Shannon). This leads to a different kind of memory-in-the-present which becomes a function of numerical values - re/counting instead of telling. Once the records have been digitized and can be coupled to *online* media, the former tension between long-time storage and immediate dissemination collapses. The technological transformation of media witnessing from an electronic analog assemblage to digital signal processing allows for new forms of time-axis manipulation, simulation and referential illusions such as the 3-D virtual testimonies" by scanning the oral history performances of Holocaust survivors for interactive re-play.

Holocaust- and technology-induced *traumata* in parallel lines

Is there a possibility for mediated testimony to let the audience share co-witnessing? Geoffrey Hartman, one of the founders of the Yale Archive, declared the essential meaning of video testimony to listen and to restore a dialogue.[283] But traumatic experience, once being recorded by testimonies on

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281 Pinchevski 2012: 145
282 Pinchevski 2012: 145, note 7
283 Geoffrey Hartman, The Longest Shadow: In the Aftermath of the Holocaust (Bloomington: Indiana UP, 1996), 133

audiovisual technologies or transmitted by radio or television, is not simply "mediated"; a significant shift and essential transformation takes place, modulated by the sub-traumatizing effect of technologically induced "presence" itself.[284] Especially in video testimony, *any* mediated experience (not only the Holocaust) becomes a non-historical experience which is the true McLuhanite "message" of the cathode-ray and magnetic tape-based technology. Apart from the historical testimony, a subliminal traumatic affect results from the medium itself. It is the *mediaura* (Samuel Weber) of the video technology as well which is traumatically at work; therefore the Holocaust video testimonies should not be reduced to the audio-visual content. The overall impact rather results in a cybernetic coupling of an electronic storage medium *(techné)* with the sensation (*aisthesis*) of the viewer.

There are several levels of time-related traumata: the so-called "historical" experience by the victims which are being discussed in an emphatic psychoanalytic discourse; the recording of testimony by technological media which leads to what Marianne Hirsch has called deeply mediated *postmemory*, the second generation Holocaust memory as received and transmitted by video testimonies, photographs, and films.[285] This results in a shift of the traumatic experience which is media-archaeologically deeply rooted traumata of irritations of re-presencing *from within* technologies like the phonograph itself - resulting into a kaskade of micro-traumatic irritations of temporal experience. This became most apparent in the present creation of traumatic experience by current "live" and "real-time" transmission itself (case 9/11). "The task of crisis-readiness is effectively that of vigilance, derived from the 'never again' imperative of Holocaust witnessing."[286]

"[...] videotestimony holds something that can never be fully narrativized. Recording and narrative are incongruous, as the one holds precisely what the other lacks: referentiality in the case of recording, chronology in the case of narrative. Whereas narrative constructs a sense of progress through time, recording captures the actual flow of time, along with the contingencies occasioned therewith."[287] Today we recognize a media-archaeological re-turn of the trauma which is de-coupled from the "testimony" discourse in two ways: a) from within technology, where defects of hardware and bugs in software equal psychic defects; b) the media-induced trauma of "bodilessness", e. g. the capacity of electronic communication media to generate within humans "a sense of instant contact irrespective of both geographical and temporal distance"[288].

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284 See Geoffrey Hartman, Memory.com: Tele-suffering and Testimony in the Dot Com Era, in: Raritan 19, no. 3 (2000), 1-18

285 Pinchevski 2012: 156, note 31, referring to: Marianne Hirsch, Family Frames: Photography, Narrative, and Postmemory (Cambridge, Mass., 1997), 12-40, and "Surviving Images: Holocaust Photographs and the Work of Postmemory," in Visual Culture and the Holocaust, 215-46

286 Amit Pinchevski / Paul Frosh (eds.), Media Witnessing: Testimony in the Age of Mass Communication, Basingstoke (Palgrave Macmillan) 2009, 300

287 Pinchevski 2012: 153

288 Roger Silverstone, The medium is the museum. Ob objects and logics in times and spaces, in: John Durant (ed.), Museums and the public understanding

Digital retro-action and the difference it makes: Digital sampling of Holocaust testimony

The sampling of recorded voices once lead to its transsubstantiation into synthetic speech - the Vocoder. In that sense, current "Digital Humanities" experimentation with big sound data takes place upon the radical premise of the inhuman.[289] For digital computers which are Turing Machines, there is no sense of history at all, just discrete memories of present states and Markov predictability dependent on past states on the data recording tape. The modelling of the human unconscious as binary machine logics by Jacques Lacan and cybernetic neuro-science has undermined the self-understanding of a privileged human subjectivity; sampled voices and digitally sampled video recordings finally result in an ongoing irritation of presence not on the discursive but on the techno-mathematical level of intermediary storage which is micro-archiving the present.

The "digitization" of records considered for historical research transforms the authenticity claim of the documentary witness (be it texts, audio or video recordings). Evidence in the digital era is elusive. Let us differentiate sharply between electro-mechanic transduction (preserving the indexial reference) and digitization of the signal (lossing it) as testimonial trace.

The technological momentum of "Messianic" time: Digitized video testimony

Geoffrey Hartman's creation of a video archive of testimony by Holocaust survivors at Yale University in 1981 has been driven by the impulse to keep that memory con-temporary. There is a medium-specific temporality of both video art[290] and video testimony which affects the human spectator: "A medium of redemption at once private and collective, videotestimony is Jetztzeit caught on tape, complete with all its 'chips of Messianic time.'"[291] It is the *mediaura* (Samuel Weber) of the video technology itself which evokes its presence effect. Digitization of such video tapes for archival preservation leads to a different kind of memory-in-the-present which becomes a function of numerical values - re/counting instead of telling. Once the records have been digitized and can be coupled to *online* media, the former gap between long-time storage and immediate dissemination collapses. Henri Bergson describes the interlacing of

of science, London (Science Museum) 1992, 34-42 (34)
289 See Todd Presner, The Ethics of the Algorithm: Close and Distant Listening to the Shoah Foundation Visual History Archive [2012], *online* http://www.toddpresner.com/wp-content/uploads/2012/09/Presner_Ethics.pdf
290 On the quasi-biological impact of the analog video image, see Ina Blom, The Autobiography of Video. The Life and Times of a Memory Technology, Berlin (Sternberg Pr.) 2016
291 Pinchevski 2012: 153, quoting Walter Benjamin, Theses on the Philosophy of History, in: same author, Illuminations: Essays and Reflections, trans. Harry Zohn, ed. Hannah Arendt (New York, 1969), 263 [New York: Schocken 1987]

present perception and past recollections as electric circuit.[292] When humans are coupled to Internet data online browsing state, memory there is not past, but a spatio-temporal latency.

Digital signal processing allows for new forms of time-axis manipulation, simulation and referential illusions. Already preceded by digital character animation in Hollywood film industry, up to algorithmic re-viving dead actors like Bruce Lee, the 3-D-scanning of Holocaust survivors for interactive re-enactment actually de-historicizes the presence of the past.

Once traumatic memory such as Holocaust survivor video testimony can be accessed on YouTube, such a kind of digital library invites users for re-mixing it in parts. Sampling in the engineering sense (digitization) suddenly corresponds with sampling in the cultural, post-modern sense, "falsifying time" (Paul Frosh) by re-integrating traumatic time (absence) into the symbolic order again.[293]

Real-time signal processing technologies in *online* and *streaming* media[294], with its chrono-aesthetics of mathematical Markov processes where the probability of reporting a single data event is modulated by the presence of an immediately earlier one, results in a "priming" process that temporarily enhances the effective gain of the perceptual "present window" on the timescale of seconds. In probability theory and statistics, a stochastic Markov process "can be thought of as 'memoryless': loosely speaking, a process satisfies the Markov property if one can make predictions for the future of the process based solely on its present state just as well as one could knowing the process's full history. i.e., conditional on the present state of the system, its future and past are independent."[295]

The almost immediate, non-linear accessability of Internet websites is more akin to what physicists call a 'wormhole' - a shortcut connecting distant points in space and time[296], a tunneling of temporal distance, a making of the past con-temporary.

PRINTED LETTERS, ACOUSTIC SPACE, REAL TIME INTERNET. The message of current communication media, deciphered with (and beyond) McLuhan

McLuhan at the borderline of digital computing

292 See Gilles Deleuze, Bergson zur Einführung, ed. and transl. Martin Weinmann, Hamburg (Junius) 1989, 87, referring to Bergson's *Matière et Mémoire*
293 An argument derived from the lecture "The Hot and Cold Channels of Co-Trauma" by Jan Claas van Treeck at the Workshop xxx, HU / HU, Jerausalem, xxx 2015
294 See Douglas Rushkoff, Present Shock. When Everything Happens Now, New York (Penguin) 2013
295 Retrieved from "https://en.wikipedia.org/w/index.php?title=Markov_process&oldid=712058457", referring to the entry "Markov process (mathematics)" in the Britannica Online Encyclopedia. Accessed 25 July, 2016
296 Frosh / Pinchevski 2009: 303

But McLuhan's apparent emphasis on electricity hampered him to conceive the computer otherwise than just in anecdotes. Maybe this was the case because he considered the ancient Greek phonetic alphabet responsible for an original sin of the occidental psyche and culture of knowledge which replaced collective *mimesis* by individualized objectivity and privileged linear, analytic, visually based acquisition of information, resulting in the geometry of control systems.

In chapter 11 of *Understanding Media* McLuhan defines the nature of the number as "an extension and separation of our most intimate and interrelating acticity, our sense of touch"[297] - when fingers are used for discrete counting. But counting in times of mechanized mathematics takes another dimension. McLuhan's *Understanding Media* finishes with a chapter on "automatization"; just up to this limit the author in 1964 perceives the computer.[298]

McLuhan, with his servomechanistic concept of man-machine symbiosis, heavily refers to the cybernetic epistemology of his days, but significantly blinds out its mathematical foundation on which Norbert Wiener always insisted - a mathematization which ultimately replaced McLuhan's vision of a synchronous, instant and resonant "acoustic space" by digital calculation.[299]

The essential von-Neumann architecture of current computing as algorithmic and storage-programmable symbolic machine is acknowledged only in the posthumously edited work *Laws of Media*). But here again, in the best tradition of the central thesis of *Understanding Media*, McLuhan (both father and son) try to identify the central "message" of the digital computer, less than its social impact which has been dominated by the "Personal Computer" concept and Graphical User Interface since.

In an uncanny way McLuhan transforms from a historicised media theorist into an up-to-date model exactly when reading his posthumous work. This after-life is part of the argument already. All of a sudden, McLuhan seems a little bit less dead, when reading his identification of computing media as a machine whose essential message is rooted in its delicate time mangement. Under this aspect, the computer as the dominant medium of today can not only be understood more precisely, but turns out to be a chrono-poet itself, actively reshaping current culture on the basic level (or *a priori*) which George Kubler once described in his *Shape of Time*. Even though this insight has been borrowed from other scholars as ever in McLuhan's fast-processing works, it is directed by a remarkable skill to identify the crucial and original arguments: "Jeremy Rifkin shows that, thanks to the computer, visual centralized time is a s obsolte as visual space. The Central Processing Unit orchestrates a ballet of operations in simultaneous times, chronology in counterpoint."[300] This is an understanding of *mousiké* in its ancient Greek sense. Here, McLuhan comes close to what has

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297   McLuhan 1964: 107

298   See Jens Schröter, Von Heiß/Kalt zu Analog/Digital. Die Automation als Grenze von McLuhans Medienanthropologie, in: de Kerckhove ete al. (eds) 2008: 304-320

299 See Martina Leeker, Camouflagen des Computers. McLuhan und die Neo-Avantgarden der 1960er Jahre, in: de Kerckhove et al. (eds) 2008: 345-374 (357)

300   Marshall McLuhan / Eric McLuhan 1988: 53

recently been termed the "algorhythmic" (Shintaro Miyazaki)[301] - carrying his notion of "acoustic space" into the digital kernel.

Thus the computer is not just time-based as performing arts and technical media before, but itself becomes chrono-poetical. A distinguishing feature of the computer is "its temporal creativity"[302]. Refering to David Bolter's *Turing's Man*[303], McLuhan points out "that while clocks are all set to the same exacting sequence, duration, and rhythm, the computer is free to manipulate all three of these temporal dimensions by merely changing the program"[304] - which is true especially for the von Neumann architecture of computing, a concrete embodiment of the algorithms as being-in-the-world, and thus: in time. "With this new timepiece, time is no longer a single fixed reference point that exists external to events. Time is now 'information' and is choreographed directly into the programs by the central processor"[305]; this choreography is media theatre in its dramatic, time-operative sense. With computers we enter the age of "multiple times" (Bolter); every program here has its own unique sequences, durations, ryhthms. "The clock dial is an analogue of the solar day, an acknowledgement that we perceive time revolving in a circle, corresponding to the rotation of the earth. In contrast, computer time is independent of nature: it creates its own context" (ibid.) - up to so-called Internet Time. Genuine media time is *Eigenzeit* just like in acoustic space every event creates its own spatiotemporal field. Indeed, the computer imprints a unique temporality into every program, which makes all the difference between an alorithms written with pencil on paper (like a musical score) and its implementation as an actually running program (like a musical performance differs from its symbolic score). The message of the computer as medium is not just its temporality, but more: its different hard- and software-biased tempo realities. The totalizing cultural and semantic reference "time" implodes. It is the timing mechanism within the computer which brings it close to what Aristoxenos once coined *chronoi* for measuring the temporal duration in music, dance and prosodic speech).[306] Media theory, today, thus needs to be algo-rhythmic itself, just as the conventional concept of media history is being replaced by chrono-archival reconfigurations and media-archaeological recursions. Thus, re-reading McLuhan still sets media theory in motion.

Understanding Media in the age of Internet

In order to understand media in the age of the Internet, let us focus on its time-critical aspects which are the message of Internet-based communication (especially in the form of so-called Web2).

301 Shintaro Miyazaki, Das Algo*rhythmische*. Microsounds an der Schwelle zwischen Klang und Rhythmus, in: Axel Volmar (ed), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 383-396
302 Marshall McLuhan / Eric McLuhan 1988: 53
303 David Bolter, Turing´s Man. Western Culture in the Computer Age, Chapel Hill (The University of North Carolina Press) 1984, 38f
304 McLuhan / McLuhan 1988: 53
305 Ibid.
306 Aristoxenus, Elementa Rhythmica. The Fragment of Book II and the Additional Evidence for Aristoxenian Rhythmic Theory, ed. Lionel Pearson, Oxford (Clarendon Press) 1990

McLuhan is not just a historical hero of media theories. Even in times of the Internet and mobile media, it is still useful to follow his advice not to ask about the content and its social implications only but to look equally at the subliminal message or rather massage which is thereby being induced.

McLuhan analysed the cultural impact of media not on the level of semantic content like communication studies, but rather directed attention to their *sublime*, non-figurative message (in the sense of Immanuel Kant and Edward Burke), that is: the ways media act upon and reshape the perceptional schemata within humans. As such, media power operates by "amplifying human sensory preceptors"[307] in their different physiological channels. Among these, the amplification of temporal schemata reigns supreme. But this amplification leads to irritations. Walter Benjamin in his 1936 essay on the work of art in the age of technical reproduction   insisted that aesthetic "aura" depends on real presence in space and time. Nervertheless, electronic television by means of *live* transmission is able to generate an impression of presence by real signal synchronicity in time across spatial distance. At the same time, human senses have difficulties to differentiate *live* from broadcasting of *live from tape* or (nowadays) digital transmission in *real time*:

"One can no longer distinguish, visually or aurally, between that which is reproduced and its reproduction <...> not even discern *that* or *when* reproduction or repetition, in the manifest sense of recording or replaying, is taking place. We must be informed whether or not what we are seeing is "live". <...> we cannot distinguish through our senses alone between what we take to be simply "alive" and what as reproduction, separated from its origin, is structurally posthumous."[308]

The liveness of media springs from their temporal effects. In a McLuhanite reading, the essential message of electronic communication transfer is in its temporal field. The previous technical media of storing physical events (photography, phonography, cinematography) have been counter-balanced by media of pure transfer in the 20th century. Prominently ranging among these has been radio based on the electronic vacuum tube and its functional successor (though irreplacable in the case of the TV monitor tube), the transistor. The thermionic tube has been the defining element of electronics as such. McLuhan neglected this decisive media-archaeological artefact, remaining a philologist rather than an engineer, thus being media scholar only half way. That is how he can write of "electricity" as the paradigmatic energy form of the present, whereas electronics does not simply mean electric energy but the directability, almost governance (both analogue and logical) of free-floating electrons in vacuum space with almost light speed, thus allowing for low-currency based information engineering.

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307 Robert Babe, McLuhan and the Electronic Archives, in: Old Messengers, New Media. The Legacy of Innis and McLuhan, Essays: Archives as Medium, *online* http://www.collectionscanada.gc.ca/innis-mcluhan/002033-4010-e.html (accessed April 29, 2009)
308 Samuel Weber, Mass Mediauras. Form, Technics, Media, Stanford (Stanford UP) 1996, 121

The characteristic of early radio has been that it broadcasted music and speech radically "live", without storing the signals at all. From that derives a general phenomenologic insight: Analog mass media like radio and television exist always only momentarily in the "now", being located in time itself.[309] In (and for) the temporal sense, radio is a "hot" medium. McLuhan's differentiation between "hot" and "cold" media can be applied to the technical modes of generating temporal affects indeed, ranging between intensive and extensive temporal involvement of the participant. The "live" effect of technical communication takes place since the age of the telephone (whereas telegraphy, intermediated by the inscription paper of dashes and dots, rather represented what we now call differential "live on tape".

Such a time-critically sharpened reading of McLuhan's medium/message theorem leads to new ways of approaching the temporal bias of technical media which is not only a macro-temporal *bias of communication* in a Harold Innis-mode of media theory, "but an intensive microtemporality."[310]

In a very different way, the temporal message of digital communication media is in temporal deferal: from *live on tape* to media content *on demand*. This is the temporal signature of webcasting.[311] This time-critical souvereignty and immediacy in access means a "tactilization" of what has been non-individual mass media broadcasting before, in fact: an almost *haptic* access to media time (to use one of McLuhan's terms. Something disappears at the same time: the clear distinction between what is present and what is past, what is transmitted "live" and what comes out of the archive. Some online-services of radio or TV channels offer access to commentaries on current news, while at the same time offering access to other commentaries on previous occasions. The delineations of the archive to the present become diffuse, almost fuzzy.

Technical *Eigenzeit* (the temporal logic inherent to media) shapes the collective perception of time; time itself looses its individual character. The study of time challenges media studies.[312] Here is the message of Internet-based communication: The dominant communication platform of today, the World Wide Web, needs to be analysed on its operative level of temporal processualities and eventalities.

Communication networks are not just topological systems being expressed by hypertextual links, but as well time-critical processes. A symptom of this is a The answer to this is a term which does not nominate a new medium but declares the temporal mode its decisive media-theoretical criterium: the *real-*

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309 See Wolfgang, Hagen, Theorien des Radios. Ästhetik und Äther, *online* www.whagen.de/seminare/AETHER/aether3.htm
310 See Jussi Parikka, Operative Media Archaeology. Wolfgang Ernst's Materialist Media Diagrammatics, in: Theory Culture & Society (forthcoming)
311 Andreas Bade, Radio im Internet. Zwei Wege für die "Stimme" im Netz, in: same author, Das Internet als programmbegleitendes Medium des Hörfunks. Historische Entwicklung von Internet, Radio und ihrer Medientheorien, Hamburg (Diplomica Verlag) 2009, 57-86, *online*: http://www.mediaculture-online.de
312 "Zeit ist damit auch die Herausforderung einer Medienwissenschaft": Stefan Rieger, Kybernetische Anthropologie. Eine Geschichte der Virtualität, Frankfurt/M. (Suhrkamp) 2003, 143

time web which is "a set of technologies and practices which enable users to receive information as soon as it is published <...>, rather than requiring that they or their software check a source periodically for updates."[313] The communicative practice of *instant messaging* belongs to this temporal field; im McLuhan's sense the message of the medium here is immediacy serving to create the illusion of a pseudo-copresence. This recent form of web economy is being defined by communication within the time-critical realm; cyberspace as *docuverse* is being replaced by an extremely accelerated information processing in cybertime.[314] The Internet thus turns out not to be just a topological extension of a generalized archive, but equally as a chrono-technical "compression of time"[315]. This requires a close look at time-critical operations on the physical and logistical level of the Internet, f. e. the "Ping" signal. In the Internet, each data packet into which a document has been sliced is being observed individually; its transfer happens independent from its preceeding or successive packages. This procedure is radically time-critical since is takes place within the so-called Time To Live-field which defines the maximal temporal duration in seconds an IP packet is allowed to exist in the Internet. A counter is progressively being reduced during this routing; in case the TTL-counter reaches zero before the packet has reached its destination, it is being annihilated.[316] Media time is not endless.

Communication, in this sense, is about time-sharing (not primarily about exchange of meaning) - just like in physics, engineerng and systems theory "communication" is about signal interaction first. This reminds of a primary scene in media archaeology, the *momentum* of telegraphy, when one of the first messages exchanged on the Morse system in the United States between Baltimore and Washington was a quest for time - with the response indicating local time in almost immediate speed, (almost) without delay.[317] The message of telegraphy in its early, that is: media-archaological phase, is (about) tempor(e)alities - coupling (synchronizing) sender and reveiver in the time domain which is, in McLuhan's sense, the tactile temporal affect. What has still been verbal time-communication between human operators on the telegrapic channel, later became the technical time signal, with the temporal signal as low frequency modulation of a high frequency signal itself being the message and not *allegorically* carrying another meaning.

The "acoustic" structure of electronic media

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313 http://en.wikipedia.org/wiki/Real-time_web (accessed January 20, 2010)

314 "Früher ging es um die Schaffung von Räumen <...>, heute geht es um die Zeit selbst, um Chronos, um die Kunst der *longue durée*": Geert Lovink, Was uns wirklich krank macht, in: Frankfurter Allgemeine Zeitung No 140, 21st June 2010, 27 (referring to the media theory of Franco Bernardi)

315 Ibid.

316 Othmar Kyas, Internet: Zugang, Utilities, Nutzung, Bergheim (DATACOM) 1994, 65

317 The topic of Florian Sprenger's talk "'Intellect hath conquered time' - The Presence of Electricity and the Rise of Telegraphy" at the conference *Global Communication Electric. Social, Cultural, and Political Aspects of Telegraphy*, 18/19 February 2001, Museum of Communication, Berlin

As a counterblast to the so-called "visual turn" or "pictorial turn" declared by W. T. Mitchell long ago, recent years proclaim another rebellion against the Gutenberg galaxy, which is the "sonic" or "acoustic turn", accompanied by new methods of making information and even knowledge accessible over the so long neglected acoustic channel of perception (audio interfaces, methods of sonification of data to the time-sensitive ear). It has been McLuhan who anticipated this turn already, a theorem bound to his analysis of the electronic age which he sharply discontinues from the machinic age.

Notwithstanding his confusing of electricity and electronics, McLuhan made a crucial discovery. In a letter to P. F. Strawson, author of *Individuals. An Essay in Descriptive Metaphysics* (1959), McLuhan quotes from that work: "Sounds, of course, have temporal relations to each other ... but they have no intrinsic spatial characters."[318] The immediacy of electricity has been valued essential by McLuhan as the definite difference to the Gutenberg world of scriptural and printed information: "Visual man is the most extreme case of abstractionism because has has separated his visual faculty from the other senses <...>. <...> today it is threatened, not by anly single factors such as television or radio, but by the electric speed of information movement in general. Electric speed is approximately the speed of light, and this consitutes an information environment that has basically an acoustic *structure*."[319]

Very media-archaeologically, McLuhan's term "acoustic structure" evidently refers to an epistemological ground, not to the acoustic figure (what ears can hear). This ground-breaking took place with the collapse of Euclidic space into Riemann spaces and culminates around 1900 with quantum physical notions (the para-sonic wave/particle dualism, up to the "superstring" theory of today) on the one side, and Henri Bergson's dynamic idea of matter as image in the sense of vibrating waves and frequencies. McLuhan's "acoustic space" means oscillating time and implicitely re-turns in Gilles Deleuze's "interval" philosophy.

In an epistemological sense, the sonic is not about (or limited to) the audible at all, but a mode of revealing modalities of temporal processuality. At the speed of light, information is simultaneous from all directions and this is the structure of the act of *hearing*, i. e. the *message* or effect of electric information is "acoustic" - even when it is perceived as an electronic image, as defined by the video artist Bill Viola in his essay "The Sound of One Line Scanning".[320]

The temporal *punctum* becomes decisive: "The *interval* is where the action *is*"[321]; unwillingly, McLuhan here graps the essence of binary data processing - the "time of non-reality" (as defined by Norbert Wiener) in switching between Zero and One.

In this aspect, McLuhan at first sight mis-interpreted electronics once more: by

318 Dated April 17, 1969. Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford University Press) 1987, 367
319 Letter to Barbara Ward, 9 February, 1973, in: McLuhan 1987: 466
320 Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (eds), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54
321 McLuhan ibid.

understanding the computer as a mere extension of electronics. The point is that the computer conceptually is not dependent on electricity at all but basically a trans-machinic medium, a "paper machine" (in terms Alan Turing). But computer culture as it actually takes place is time-critically bound to electric speed indeed.

"Tetrads": Alternative media historiograms

Marshall McLuhan and his son Eric figure as co-authors of a final work which claims an encompassing theory of media (in) time: *Laws of Media*.[322] The sub-titel of this work ("The New Science") explicitely refers to Giambattista Vico's model of recurrent states in cultural history; for media history, McLuhan calls them "tetrads", graphically expressing the dis/appearance of hidden or unnotified qualities of technologies in culture.

With all his sometimes stupifying imprecisions in media analysis, McLuhan had a stunning sense for alternatives to media historiography as simple history of technologies or cultural history. These alternatives do not result from distant reflection only but from media themselves.

"Just as linear history begins with writing, it ends with TV."[323] In the 1954 version of Marshall McLuhan's pamphlet *Counterblast* the "Media Log" is explicit: "Sigfried Giedion has had to invent the concept of an 'anonymous history' in order to write an account of the new technological culture."[324] In another version of the pamphlet McLuhan declares: "Just as there was no history when there was no linear time sense, so there is post-history now when everything that ever was in the world becomes simultaneously present to our consciousness."[325]

Illustrative of this is oscillating state (though here paradoxically taking place in a static spatial image form) is the mural painting in McLuhan's seminar room at Toronto university campus: René Cera, *Pied Pipers All* (1969).[326]

Since the dominant mass medium of his age, television, has been McLuhan's research-guiding medium, it is from the time-critical nature of the electronic image that McLuhan derives his insight into the radically temporal message of hight-technological media: "You are drawn into that tube, as an inner trip. You ´re totally involved. You have no objectivity, no distance. And it is acoustic. It resonates. But this is a hidden ground, because superficially people think the

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322 Marshall McLuhan / Eric McLuhan, Laws of Media. The New Science, Toronto / Buffalo / London (Univ. of Toronto Press) 1988

323 Marshall McLuhan, Counterblast, New York (Harcourt, Brace & World) 1969, 122, as quoted in Bexte 2008: 332. This diagnosis has been shared by the media philosopher Vilém Flusser in his writings on the alphabet and on the nature of the technical image.

324 Recently re-published on occasion of the media arts festival *transmediale.11* in Berlin (in cooperation with Gingko Press) in 2011

325 McLuhan 1969: 122

326 Photographic colour reproduction in: de Kerckhove et al. (eds) 2008: 331

´re looking at a visual program. And they´re not. They´re not looking at all - they´re absorbed, involved in a resonating experience."[327]

But today, such formerly "acoustic" TV images consist of digital pixels (different from the cathode ray "mosaic" of the iconoscope as referred to in McLuhan's times).

In terms of analyzing current computer-based media culture, McLuhan's electricity-centered approach seems antiquated. But when it comes to apply his critique of technical communication to the re-thinking of media history, the replacement of scriptural linearity by "sonic" resonance becomes productive. "Resonance" is McLuhan's central figure of dynamic temporality taking place in acoustic space which is "organic and integral, perceived through the simultaneous interplay of all the senses", a kind of "echoland"[328] - sonic time rather than history.

Electromagnetic signals are capable to evoke almost immediate effects in a resonant receiving system. Resonance compares to the dynamic tempor(e)ality of the electro-magnetic field rather than to the monodimensional transmission in a linear channel. Such interpretations of electronic communication which intermediates between humans expressively refer to the non-linear epistemology of the sonic temporal field[329] and thus provide a model for non-historic ways of writing media time. In a benevolent re-reading, McLuhan's notion of the "tetrad" suggests a diagrammatic media archaeology dealing with recursive reconfigurations.

Artists, in their time, function as "the antennae of the race" who "had tuned in to the new ground and begun exploring of discontinuity and simultaneity"[330]. This is not meant metaphorically, but uses terms of radio technology. They quote from T. E. Eliot's 1917 essay on "Tradition and the Individual Talent" where what Eliot named *historical sense* is - in McLuhan's paraphrase - the awareness of a "resonant interplay". According to Eliot, the whole of the literature of Europe from Homer "has a simultaneous existence and composes a simultaneous order"[331]. Instead of historicism, this is a sonic model, a superimposition of wave forms which are distant in terms of historical time but immediate to each other media-archaeologically. This modality is genuinely con-temporary, a "resonant interval" - an expression which McLuhan once borrowed from quantum physics. At that point, this is media theory no more.

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327 McLuhan in interview with Jerry Brown, in: The CoEvolution Quarterly, Winter 1977/78: Letters of Marshall McLuhan, selected and edited by Matie Molinaro / Corinne McLuhan / William Toye, Toronto / Oxford / New York (Oxford UP) 1987, 177
328 Marshall McLuhan, The Playboy Interview: Marshall McLuhan, in: Playboy Magazine, März 1969; reprint in: Eric McLuhan / Frank Zingrone (eds), The Essential McLuhan, London (Routledge) 1997, 233-269 (*online* www.columbia.edu/~log2/mediablogs/McLuhanPBinterview.htm)
329 "In watching television, our eyes function like our ears": Schwartz 1974: 14
330 McLuhan / McLuhan 1988: 47
331 T. S. Eliot, Selected Essays, quoted in McLuhan / McLuhan 1988: 48

MEDIA ARCHAEOLOGIES OF THE RECENT PRESENT

Contemporary culture increasingly indulges in ubiquitous computing. A media archaeology of this technological present reminds of its underlying technical and logical pre-conditions. Contrary to the intuitive understanding, "media archeologies of the present" is *not* about the most recent technological events which govern our contemporary techno-social condition. The printed timeline *Tracing Information Society*[332] starts with 1900. But when do media conditions "begin"? Any "media archaeology of the recent past" finds itself in a blind spot: The *archive* of the present, which in Michel Foucault's sense is the techno-logical *a priori* of multi-media enunciation, by definition is not accessible. A media archaeology of the present refers to technological infrastructures, not to narratives, questioning the suggestive linearity of the "timeline" itself, in favor of alternative chrono-poetics such as algorithmic timestretching. Different from a linear sequence in chronological order, media-archaeological analysis zig-zags back and forth on (and against) the technopolitical "timeline" of information society, close to the actual step-wise operations of the turingmachine reading / writing head.

While "social media" platforms like Facebook, Twitter, and Instagram have long been functionally and visually organized on the explicit "Timeline", this chronicle-like symbolical order of time is displaced by the Newsfeed algorithm, a dynamic cluster of different factors or coefficients structuring the representation of events, while with the instant messaging service Snapchat, recorded events become visible for a fraction of time only; the present becomes ephemeral again. But in global communication networks, the time zones still reign.

"Media archaeologies of the present" as non-historicist diagnosis of Information Society

A linear timeline misses the complex non-linear constellations which redefine the "recent" technological past. According to Walter Benjamin's *Theses on History*, the past "flashes" into the temporal now ("Jetzt-Zeit"). In reverse, the "Now" becomes antiquity almost immediately. The contemporary condition dates back to basic, recurrent technologies which are *recent* in the literal sense. German "rezent", as defined in the dictionary, in the biological context means "gegenwärtig [noch] lebend, auftretend oder sich bildend"; in Austrian use of speech, "rezent" means "zeitgenössisch, aktuell, vor Kurzem entstanden."[333]

Digitization means archaeologisation in the sense of mathematising the present. The Instant Archaeology Concept, connecting computer data bases with digital editing, has been developed by Michael Mikina and Francis Wittenberger for Digitale '98 festival at the Cologne Academy of Media Arts. The video material during the festival was recorded in a away that allowed for an individual editing in real-time.[334]

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332 http://www.technopolitics.info/Timeline
333 http://www.duden.de/rechtschreibung/rezent; 27. Oktober 2016

Further entries into the "Time Line"

The escapement-driven clock: The invention of the escapement-driven clock is non-dated. The historian of culture insists: "A timepiece is much more than a mechanism. To attempt to understand it in isolation from its human setting is to forget that it was made in the first place in response to specific human needs."[335] But when such a mechanical clock is in operation, its functions depend on a genuinely media-governed logic which is at work indifferent to its application in a medieval monastery of the past or a museum of the present. The message of the media mechanism is not only the acoustic signal which is decoded by human ears as an indicator of temporal measurement, but as well a media-physical reminder of frequencies and oscillations, rhythm and repetition - basic media-archaeological ingredients in the study of nature. The coming-into-being of the mechanical escapement which (apparently from the 13th century) is the new media-epistemological feature of the mechanical clock in the strict sense is as much bound to moments of cultural history as it is bound to techno-logical laws which operate in an an-historical temporal regime, and its "tradition" is as much a function of survival of knowledge on (especially astronomical) wheel-driven clocks (astrolabs) from antiquity to medieval times as it is part of a techno-logical self-reference which is only partly identical with discoursive variations of human history. The decisive mechanism which distinguishes the "truly mechanical clock" (J. D. North) from traditional astronomical mechanisms is the verge or foliot escapement (such as Giovanni de´Dondi clock) which is later being replaced by the pendulum. Periods of swing (oscillations) which had been cultural knowledge as long as it was restricted to observation of planetary systems for agricultural use all of the sudded became a fundamental parameter for micro-temporal events, opening my media-operative measuring devices insight into a world of time-critical operations unknown to human perception (*aisthesis* / aesthetics) before. Media archeology does not extend its ambition to explain the ways in which an oscillatory mechanism for both measuring time and striking a bell in the thirteenth century "was obsorbed into the high ritual of the church" and why this was "fitting"[336]; the canonical hours of the monastic life - especially in the Cisterian rule where Rule XCIV ask both for *horologium temperare* and *facere sonare* - almost inevitably asked for automatic control sooner or later, but the other driving energy for the development of the mechanical clock, the desire to cause a clock to sound on its own, operates on a level which is closer to science than to religion. Parallel to this cultural logic, something else is at work; media archaeology rather pays attention to the fact that below this apparent cultural use something was established on a level sub-conscious to culture and

334 On the concept of "instant archaeology", see Siegfried Zielinski, (An-)Archive. Die Abschaffung der Gegenwart und das Archiv der Zukunft, in: Bernhard Serexhe (ed.), Konservierung digitaler Kunst: Theorie und Praxis. Das Projekt digital art conservation, Karlsruhe (ZKM) / Wien (AMBRA) 2013, 95-113 (100
335 J. D. North, Monasticism and the First Mechanical Clocks, in: J. T. Fraser / N. Lawrence (eds.), The Study of Time II. Proceedings of the Second Conference of the International Soeciety for the Study of Time Lake Yamanaka - Japan, Berlin / Heidelberg / New York (Springer) 1975, 381-398 (381)
336 North 1975: 393

religion: a training of sensibility to micro-temporal events. While the essence of sound had been a favourite topic of analysis in early Greek philosophy and musicology (from Pythagoras onwards), its media-technological reproduction by oscillatory mechanisms follows a logics of its own. At this cross-road between culture and physics media archaeology steps in.

Cinematography: Media history usually dates cinematography back to 1895, with its first public screening (*The arrival of a train*) in Paris by the Lumiére brothers. But this vintage drama is not historical; in way, the train arrives again. In recent years, the "post-digital" in media art has been announced, such as the "archaeological" use of anachronistic media like early 16mm film - a retro-effect of temporal snapshots against digital atemporality, an archaic counter-practice.[337]

The flip-flop: In September 1919 Eccles and Jordan described the flip-flop in a brief one-page paper "A trigger relay utilizing three-electrode thermionic vacuum tubes"[338]. In the previous year (June 21, 1918), Eccles & Jordan *implicitely* invented the vacuum-tube based trigger circuit or multivibrator as circuitry which only retrospectively is identified as the "first" flipflop circuit, the basis for binary electronic memory. Media-archaeologically prior to the invention of electronic computing, Eccles and Jordan described their invention as a "method of relaying or magnifying in electrical ciruits for use in telegraphy and telephony". Implicitely, a flip-flop circuit embodies two stable states. It takes a timeline shift to link to Claude Shannon's "A Mathematical Theory of Communication" (1948) pointing out that a flip-flop can be used to store one bit of information and flip-flop circuits can operate symbolic algebra by Boolean two-valued algebra (AND, OR, NOT). "Using vacuum tubes as switches, flip-flops became the basic storage element in sequential logic used in digital circuitry, and the basis for electronic memory."[339]

Independently, in the early Soviet Union, Bonch-Brujevich in 1919 defines the same electronic coupling for radio signal transmission.[340] Such co-originality expresses a non-linear temporality of techno-logistical coming-to-articulation, subverting the timeline. Instead of a linear history of technologies, there is diagrammatic "path dependency" in technical individuation rather than the linear timeline historiogram of technical evolution. If the analysis of information society is meant to be "traced" rather than narrated, media archaeography is required. There are temporal modalities, or time-scales, which escape the timeline, such as cyclical patterning of "techno-economic paradigms"[341] (so-called Kondratieff waves). Cultural experimentation and techno-aesthetic discoveries may be "out of sync", in relation to such long wave patterns of around 50 years. Such macro level cycles may be applied to techno-aesthetics,

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337 See Malin Wahlberg, A Relative Timetable. Picturing time in the era of new media, in: John Fullerton / Jan Olsson (eds.) 2004: 93-103
338 In: The Electrician, vol. 83, (September 19, 1919), 298
339 http://www.historyofinformation.com/expanded.php?id=4061; accessed November 3, 2016
340 See Nitussov / Trogemann / Ernst (eds.), Computing in Russia, Braunschwieg (Vieweg) 2002
341 As expressed in Michael Century's forthcoming book on experimental media culture in Canada 1968-90 (contracted for publication with MIT Press)

experimenting with alternative modes of writing history of media. The concept of technological nonlinear "path dependency" (as applied by Pinch / Trocco in their synthesizer-book *Analog Days*) recalls Fernand Braudel's triad of temporalities (immobile history on the geological or climate level, the *longue durée* of cultural time, and finally the event level. Media have their own time and temporality, rather in self-stabilizing intervals than as linear unfolding.

The turingmachine, 1936: The timeline becomes operative when conceived like the "tape" of the Turing machine, scanning the entries and removing them back or forth as a function of the media-archaeological "program" table of media-archaeological reasoning. The very entry 1936 (Turing, "On computable numbers") will thereby transform into a write/read operation of the turingmachine itself : "Das Medienzeitalter, im Unterschied zur Geschichte - die es beendet - läuft ruckhaft wie Turings Papierband. Von der Remington über die Turing-Maschine zur Mikroelektronik, von der Mechanisierung über die Automatisierung zur Implementierung einer Schrift, die Ziffer und nicht Sinn ist [...]."[342]

The turingmachine scans an entry in a square from the paper tape, which in combination with the instruction by the command list results in a specific "m-configuration" at a given time[343]. "These events occur only at discrete 'moments' - between which nothing happens [...] like the ticking of a clock [...]."[344] This is archival, symbolically ordered temporality, a kind of kinematographical apparatus where the read/write head takes chrono-photographic snapshots of the machine state.

Such kind of operation reenacts the early Mediaeval form of registering events. The Annalistic writing system (as opposed to chronicles and historiography proper) conveys a way of experiencing reality not in terms of continuous but in discrete time[345], closer to state-based automata with discrete writing/reading of symbols on an endless memory tape (the diagram of the Turing Machine).

A media archaeology of the present is not only non-linear (in the sense of Manuel DeLanda's proposal *A Thousand Years of Non Linear History* (1997), but even non-human. Providing insights into the non-human nature of technological tempor(e)alities is a specific interest of media archaeological sense of time.[346]

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342 Friedrich Kittler, Grammophon - Film - Typewriter, Berlin (Brinkmann & Bose) 1986, 33
343 William Aspray, John von Neumann and the Origins of Modern Computing, Cambridge, Mass. / London (MIT Press) 1990, 176
344 Marvin L. Minsky, Computation. Finite and infinite machines, Englewood Cliffs, New Jersey (Prentice-Hall) 1967, 12
345 Hayden White, The Value of Narrativity in the Representation of Reality, in: Critical Inquiry vol. 7 no. 1 (autumn 1980), 5-27
346 See Michael Goddard, Opening up the black boxes: Media archaeology, 'anarchaeology' and media materiality, published 28 April 2014 in the online journal New Media & Society, http://nms.sagepub.com/content/early/2014/04/27/1461444814532193

"Media cross one another in time, which is no longer history"[347], but rather re-entries of past technologies within the new.

Between remake and re-mediation (Bolter / Grusin 1999), certain technologial media apparatus and artefacts sometimes reoccur; historicizing media analysis accentuates this *discursive* force, whereas media archaeology lets the non-discursive real of such processes speak. Media historiography semanticizes technological events, while media archaeology is the articulation of the indexical trace.

Telegraphy, for example, is not an outdated communication technology from the nineteenth century; beyond its obsolete technical implemenation in cables and electro-magnetic relays, its endurance is the "digital" *avant la lettre*, different from analog radio and television signal transmission inbetween.

Discrete time signal processing has been implemented in electronic modules such as the sample and hold circuits, analog delay lines, and analog feedback shift registers as predecessors of digital signal procesing. There is a current re-entry of analog computing as mathematical modelling. An analog computer, modeling a real physical system, uses its physical quantities to represent the behaviour of another physical system, or mathematical function.[348] Even if it is obsolete in techno-historical terms, the analog computer media-archaeologically re-occurs in quantum computing, thereby questioning the linear timeline.

Fourier transform: In terms of a media archaeology of the present Information Society, Joseph Fourier's 1822 *Theory of Heat* provided for the mathematical condition of techno-mathematical Digital Signal Processing. Fourier Transform converts a mathematical function of time into a new function whose argument is frequency counted in cycles per second (hertz)[349], thus transforming the time domain of a signal into its frequency domain which is discrete numerical values. Discrete-time Fourier Transform facilitates digital storage and computation of physical (real-world) signals and their replay, since the operation can be reversed from the frequency domain back into the time domain. Such high-fidelity reconstruction of signals is not simply essential for audio and video reproduction technologies today, but for inquiries into the non-historical nature of media tempor(e)alities as well. The Moebius loop like entanglement between the time and frequency, between analogue vibrations and discrete numbers, is the essence of a time machine which is physical and symbolic at the same time: *algorhythmics*[350].

In 1965, James Cooley and John Tukey published a paper "re-inventing the algorithm of Fourier Transform and describing how to perform it conveniently

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347 Friedrich A. Kittler, Gramophone, Film, Typewriter, Stanford, CA (Stanford University Press) 1999, 115
348 See http://en.wikipedia.org/wiki/Analog_computer; last modified 29. April 2007
349en.wikipedia, "Fourier transform", accessed September 27, 2013
350See Shintaro Miyazaki, Algorithmics. Understanding Micro-Temporality in Computational Cultures, *online* in: Computational Culture, Issue 2 / 2012 (http://computationalculture.net)

on a computer."[351] Against its suggestive expression, Fast Fourier Transform is not simply an escalation of computational speed but resulted in a new object of knowledge in terms of Process-Oriented Ontology. FFT has been included in the Top 10 Algorithms of 20th Century by the IEEE journal Computing in Science & Engineering.[352] In principle (*en arché*), this algorithm, including its recursive application, was implicitely invented around 1805 by Carl Friedrich Gauss, who used it to interpolate the trajectories of asteroids. Published only posthumously, the recipy of Gauss' asymptotic computational time remained in latency; still it is implicitly operative in present ubiqutous computing. At that point, the suggestive timeline actually *mis*represents the archaeology of media knowledge.

YouTube: The domain name www.youtube.com was activated on February 14, 2005 and has since become the substitute for a missing audio-visual "library" of the WWW (no "archive"). In 1996, being aware of the accelerating obsolescence of Web pages in the Internet, Brewster Kahle started the Internet Archive http://www.archive.org which soon provided for an additional symbolic time machine: the Wayback Machine, implemented in 2001, which for an Internet address (URL) presents a chronologically ordered list of links to the same web page at different times.

The current Internet may be associated with previous communication networks like the horse-based postal system of the Persian empire (Innis, *Bias of Communication*) and the telegraph network in nineteenth century, a reconciliation of the high-technological present to the cultural past; radical archaeology of communication media concentrates on the non-linear discontinuities which challenge even the human as central agency of such processes. Paul Baran's proposal for packet switching distribution in the US military digital ARPAnet makes the decisive conceptual difference. Media archaeology is both about identifying the logical precondition and the actual escalation of such constellations.

Questioning the "Time line"

Let time "finally" fold the timeline upon itself, like a Moebius loop. The first timeline has been a diagram designed by the founder of graphical methods of statistics William Playfair, an engineer and political economist. the line, area and bar chart of economic data. Playfair's trade-balance time-series chart has been published in his Commercial and Political Atlas, in 1786.[353] But instead of being an external function of linear time, technology since has auto-poietically generated its own "time axis" as differential signal in every oscilloscope to measure electrified time signals.

There is no time in a graphical timeline; this is a geometric spatialization, a visual suggestion of one-directional sequences of events. Temporal processuality is claimed here only symbolically, different from any physical or

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351 https://en.wikipedia.org/wiki/Cooley%E2%80%93Tukey_FFT_algorithm (3-11-16)

352 https://en.wikipedia.org/wiki/Fast_Fourier_transform (3-11-2016)

353 https://en.wikipedia.org/wiki/William_Playfair; accessed Nov 3, 2016

technical signal. In the physical world, the time axis is synonymous with the one-directional "time arrow" as defined in 1927 by Arthur Stanley Eddington.

With technological operations, we are actually within time, not in simply symbolic "historical" time. Symbol time returns with informational entropy.

The current Technopolitics Salon "Media archeologies of the present" primarily refers to "*Dinge die in den letzten 20 Jahren passiert sind*" (Armin Medosch); in a parallel Transmediale project, the present even extends to "100 years". The timeline is supplied with names, years, and subject headings. But the media-archaeological question is not primarily about "beginnings" and moments in the historic timeline, but rather the crucial epistemological and structural moments and momentum worth to be identified and analyzed.

Google's N-gram viewer searches the full texts of some 15 million books for semantic terms and plots their frequency over a timeline. Alternatives to the linear concept of a techno-political timeline are foldings and recursions in the sense of McLuhan's *Laws of Media* ("Tetrads"); non-linear time is expressed as well in the Nyquist-criterium of physical equilibrium and the "chaotic" oscillations in the Chua electronic circuit; sociology of technology knows the diagramatic model of path-dependence. "Recursions fold time and thus enable direct contact between points and events [...] that are separated when history time is stretched out on a continuous line."[354]

In a "Timeline" of storage techniques from A.D. 77 to 2014[355], the chronological axis is boring; US computer industry privileges the linear outlook into an increasingly powerful future of storage media, instead of admitting the aporetic dead-end of Moore's Law ca. 2030. Moore's Law, the observation that the number of transistors in a dense integrated circuit doubles approximately every two years, has been formulated in 1965 to define the growth of processing power and memory capactiy in micro processors, in graphic expression on a timeline is a logarithmic function. The timeline of Information Society as archaeology of the present should be Janus-faced, anticipating the "future in the past" (*futurum exactum*) already for around 2030 as dead end. Gordon Moore, the co-founder of Fairchild Semiconductor and Intel, in his paper described a doubling every year in the number of components per integrated circuit; in 1975 he revised the forecast to doubling every two years. The very condition for Information Society has a sense of its own ending.

Nonlinear, rather "epochal" media-archaegraphy is resistance against the narrative-linearity which seduces to interfere with biographical data by the spectator.

How do you draw time?", Rosenberg and Grafton ask in their 2010 study. The answer is on the micro-computational level. Here, contemporary information culture has the means to actually cope with temporal complexity. The "time line" concept which started with Playfair in eighteenth-century but is an out-dated way of symbolically reducing temporal complexity (Koselleck, Luhman) to linear history. The timeline as info-graphics on display here explicitly is a print-

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354 Winthrop-Young, op. cit., note 5
355 http://www.computerhistory.org/storageengine/timeline

out on paper; this affords physical space experience; the time of reading can be controlled by the visitor him/herself like a museum walk, different to externally defined video streaming. The timeline privileges the visual cognition of techno-temporality; an alternative option is a truly time-based form of knowledge access: sonification, by parameter mapping of the data entries.

A complex interrelation between the components of the "Tracing Information Society" installation has been proposed by the "dynamic-abstract" diagrams developed by Doron Goldfarb with algorithms and codes: the data-aesthetics of Digital Humanities, allowing for *n*-dimensional analysis rather than focus on one-dimensional time line. Instead of the graphically linear time, an interactive diagram allows for "diffractive time" (Paula Barad).

Traditional stratigraphic time "exhibits succession but not duration"[356], but the more advanced so-called "Harris matrix"[357] for archaeological excavation of cultural sites puts emphasis on differential series rather than on geological layers. The temporal evidence for data on computer hard drives and storage media is flat and rather archaeo-*logical* in the strict sense. It requires special software for an artifical chronological listing as "timeline" of all activities which have been enacted on such a data carrier, based on the analysis of file systems, log- and registry informations.[358]

David Gelernter's candidate for replacing the current desktop metaphor is called "Lifestreams"[359]. Since December 15, 2011, the "timeline" has been the order in which all the content of Facebook users is organized and shown. But within the computer, the reading / writing head of a Turing machine only apparently "inscribes symbols one by one in an infinite string, giving rise to time as a sequence-stream, exactly as in classical mechanics."[360] But the turingmachine memory tape itself, moving back and forth, has replaced the linear timeline.

Media archaeology is time-reversed analysis. Rather than nostalgically looking back to "dead media" as the fossils of past technologies, it attempts epistemological reverse engineering – a taking apart of contemporary technologies to see in them temporal superimpositions. Techno-logical traces of the past, in the current hardware conditions, are polychronic assemblages of past technical solutions with have actual effects on (literally con-temporary culture. Media technology does not ask for external discursive narrativization any more, but itself exposes its knots or folds of technical developments in its

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356 V. G. Childe, A Short Introduction to Archaeology, New York (Collier Books) 1962, 30 (as quoted in Kusch 1991: 8)
357 E. C. Harris, Principles of Archaeological Stratigraphy, London (Academic Press) 1979
358 See http://www.sleuthkit.org
359 David Gelernter, Machine Beauty. Elegance and the Heart of Technology, New York (Basic Books) 1997, 102
360 As summarised by Francisco J. Varela, The Specious Present. A Neurophenomenolgy of Time Consciusness, in: Jean Petitot / same author / Bernhard Pachoud / Jean-Michel Roy (eds.), Naturalizing Phenomenology. Issues in Contemporary Phenomenolgy and Cognitive Science, Stanford (Stanford UP) 1999, 266-316 (268)

layers of engineering. Rather than being seduced by a linear, narrative timeline, let us attend for such unexpexted moments,.

Undermining the "timeline": Timestretching

It has been in musical notation (since Guido of Arezzo) that a symbolic "timeline" has been introduced which is quantized by interval marks of beats, with the notes on the y-axis being a function of the non-variable t which is the x-axis. Etymologically, *timing* itself means "dividing". The sonic "present" itself, taken at face value, becomes subject to micro-temporal manipulations. Karlheinz Stockhausen started his tonal compositions by phase-shifting of electric signals in the sonic "time field"[361].

The apparent linearity of time had already been irritated by Muybridge's and Marey's chonophotographical sampling of micro-temporal moments; temporal zigzags provided composers like Paul Hindemith with paradigms through which to explore the manipulation of both time and motion as infinitely divisible properties - the master paradox of Zeno's arrow as discussed film-critically by Henri Bergson in *L'Évolution Créatrice*. Hindemith's one-act opera *Hin und Zurück* (1927) plays with conceptions of temporal reversal. The music, running forward and backward, evokes such time axis manipulation.[362] *Online*-navigation in data bank, nowadays, leads to a permanent " re-programming" of the temporal entries ("Zeitstellen") on the historic timeline."[363]

A micro-"archaeology of the present" has been in(tro)duced by signal processing. Different from a linear timeline, the "time series" (Norbert Wiener) has become the central feature of signal analysis of the cybernetic present.

Once sound or light waves have been transformed into frequency values, computable reality results in "a quantifiable, nonhuman time"[364]; signal processing is independent of the narrative time line. "It is only with multimedia interface metaphors that the timeline has re-entered into computational space.

A further, "final" proposal points to limits of the visual timeline graphics itself, to be replaced the temporalities of "acoustic space" (McLuhan). Time warping and rhythm manipulation such as introduced in the audio engineering software packet Ableton Live, time stretching and time compression as introduced with the ACAI sampler, are operations introduced into audio engineering with the arrival of the digital sampler since the late 1980s. The sonic present can since be extended to the immediate past as "retention" or future as "protention" in

361 Karlheinz Stockhausen, ... wie die Zeit vergeht ..., in: Die Reihe. Information über serielle Musik, no. 3, Universal Edition, Wien / Zürich / London (1957), 13-42
362 David Trippett, Composing Time: Zeno's Arrow, Hindemith's Erinnerung, and Satie's Instantanéisme, in: The Journal of Musicology, Vol. 24, Issue 4 (2007), 522–580 (paraphrased abstract)
363 Wolfgang Hagen, "Being There!" Epistemologische Skizzen zur Smartphone-Fotografie, in: Bildwerte. Visualität in der digitalen Medienkultur, transcript Verlag, Bielefeld 2013, 103-131
364 Kittler 1999: 170 f.

Husserl's phenomenological terms, thereby technically emulating the human "inner sense of time" itself. While with the firmly inscribed phonographic groove of analog recording as material micro-timeline, changing pitch without affecting speed has been impossible, sono-poetical algorithms now allow to dis-continue the apparent temporal flow of time itself - resulting in an aesthetics of loosely coupled time as a key feature of our contemporary media condition.

SYNCHRONIZATION BETWEEN HUMANS, BETWEEN HUMANS AND NON-HUMANS, AND INBETWEEN NON-HUMANS AT ALL

Synchronicity as message of the measuring medium

Complementary to cognitive studies, the un-affective, media-archaeological analysis of technological synchronization sharpens the wareness of signal processing within the human as well. It is by autocorrelation that the human brain fuses sequential impulses with ultra-short distance into one "tonal" impression in its time-critical, that is: sonic (not acoustic) sense. The musical "consonance" theory can be media-experimentally enacted by EEG measuring; it is the "coincidence neuron" which compares the primary signal with the delayed one.[365] Here, synchronization (German *Gleichzeitigkeit*) actually happens within a fuzzy region of tolerance, since mental pattern recognition is dynamically co-emergent, not a function of a single hidden command organ like an oscillating clock.

This is the moment for Gottfried Leibniz' theory of pre-established harmony which explains how all wordly substances, though autonomous in themselves ("windowless", as defined in his *Monadology*, § 7), still "seem to causally interact with each other because they have been programmed by God in advance to 'harmonize'"[366]. But ifferent from Leibniz' philosophical approach, it is by measuring and modelling media only that this can be techno-mathematically imagined, like the van der Pol oscillator simulating the relaxation moment in neuronal cells with a gas-filled (neon) tube (Thyratron) and slowly charged capacitors which then abruptly discharge.[367]

There is an incommensurability between phenomenon of synchronization and tehnological synchronicity. Truly time-critical insight is a function of the measuring media itself: a net of electrodes allows to register the activity of numerous neurons at the same time, resulting in the impression that neurons "fire" in coordinated pace, as "synchronous oscillation"[368]. Such neurological insight into the primordial synchronization of "firing" impulses itself is a function of high-sensitive measuring media; the detection of such a time-critical mechanism, at the limits of laboratory experimentation, requires

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365 See Martin Ebeling, Verschmelzung und neuronale Autokorrelation als Grundlage einer Konsonanztheorie, Frankfurt/M. et al. (Peter Lang) 2007, 52
366 Wikipedia entry on "pre-estalished harmony", accessed September 27, 2017
367 See György Buzsáki, Rhythms of the Brain, New York (Oxford UP) 2006, 138 (fig. 139)
368 Barbara Hobom, Auf der Suche nach der universellen Sprache des Gehirns, in: Frankfurter Allgemeine Zeitung no. 284, 6 December, 2006, N2

algorithmic and information-processing mathematical modelling, which makes all the difference between emerging synchronization and synchronicity. The gap opens with "posthuman rhythmatics" in contemporary popular music culture. Edgar Varèse, in 1936, predicted machines which could generate any arbitrary sound and beat or micro-durational pause - fractions of time in all ratios and exact repetition[369] - in fact Lev Termen's *Rhythmicon*.

In terms of analysis, the human-machine-constallation is a synchronizing in a different sense, for example the laboratory measuring of human nerve reaction times by the microtime-critical Hipp chronometer in nineteenth century physiological laboratories. Once the human is coupled to the measuring instrument, he or she is synchronized with its inherent temporalty; the temporal content of the resulting data looks human, but the message of such time-data is the chronopoetics of the machine itself.

Synchronization from a media-archaeological perspective

Media archaeology, in its reactualization of cybernetic systems theory, analyzes signal transduction both in humans and in machines, while at the same time paying attention to discontinuities and asynchronicities inbetween them.

[There is communication of temporalities, even when machines communicate with machines. Still, such communication is not nonhuman at all, since all such devices are direct artefactual functions of techno-cultural knowledge, this is, they have been created from within the human world. Technology is physically reified mind, resulting in a second nature, akin to Hegel's and Gotthard Günther's notion of "objective *Geist*" and the "second machine" *alias* computing.]

While performative "embodied cognition" differs from operative technical *implementation*, time-critical processes within human cognition and within technological systems can be correlated indeed.[370] Human-machine interfaces increasingly interlace both signal events. Once humans are coupled to processual media, they are coupled to their tempor(e)alities; synchronisation is a forceful coupling in the time-domain.

The media-archaeologial approach does not apply neurophenomenological analysis but an object- and process-oriented ontology of synchronization *from within* the technical apparatus. For technologies, there is no "time", since there is no phenomenological perception and "inner time" self-consciousness. Instead, we find a variety and "kosmos" of temporal operations which unfold, the tempo*real*.

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369 "[...] das alles in vorgegebenen Zeiteinheiten, die ein Mensch nie einzuhalten vermöchte": Varèse, as quoted in: Kodwo Eshun, Heller als die Sonne. Abenteuer in der Sonic Fiction, Berlin (ID-Verl.) 2xxx, chap. 6 "Rhythmatische Frequenzen programmieren", 93-110 [EO xxx], 94
370 See Arkady Pikorsky et al., Synchronization. A universal concept in non-linear sciences, Cambridge (UP) 2003

Technological reification of time-keeping has resulted in the commodification of temporality itself.[371] With cinematography as technical operation, in Bergson's criticism of what Heidegger later would call "vulgar time" in reference to the mechanical clock, only the representation of time has become reproducible, while disavowing any relation to temporality as such. In that sense, synchronisation is a coupling and has nothing "temporal" in itself which exists only in the the Kantean sense as mental condition (*a priori*) for the human possibility of perception.

Clock-based technical synchronization itself needs to be synchronized: "Through isochronic oscillation the pendulum can exist as the autonomous embodiment of natural or physical time"[372], while the radio controlled clock needs to be periodically synchronized with a reference clock elsewhere. "The quartz oscillators used in digital electronics (which are used for synchronization rather than timekeeping) can drift [...]" (Reding / Palasti).

Media archaeology is less about the human use of technologies or instruments but about the co-agency of the machine. Some neurons in the human brain tend to "fire" in periodic frequencies and require synchronization in cognitive perception; that induces their modelling by technical oscillators. The moment humans are coupled to a machine / instrument, they become subject (like coupled clock oscillation: Huyghens) to their proper media time (Eigenzeit). This escalates with vibration / oscillating mechanisms which induce resonances within the human sense of time.

The human coupling to humans is performative; the machine coupling to machines is operative. A notorious enactment of the sublime borderlines between synchronicity and asynchronicity is the "phasing" technique applied by Steve Reich in his piece *Piano Phase* from 1967.[373] This chrono-poetics results from magnetic tape recording and its options for subtle time axis manipulation, while failing when this composition is performed by human pianists. Syn- and Desynchronosiation between even the most skilled musicians is alway fuzzy, delayed synchronicity. Entrainment analysis between two players itself is a function of time-critical techno-mathematic motion tracking and capturing, with software platform tools like Eyeweb reiterating Marey's chronophotographic measuring of movement more than a century ago. The difference itself is a technological escalation: the option for realtime analysis enabling immediate feedback and modeling for performers as co-agency instead of belated reading of recordings. *Nota bene*, a synchronization algorithm measures data resulting from sensors, not movement as it occurs - the Bergsonean critique of cinematography.

[Media-archaeological artefact collections do not simply preserve machine elements but maintain them in a (re-)enactable state. Technical devices are in their media situation only when being in action, thatis is: signal processing.]

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371 See Mary Ann Doane, Has Time Become Space?, in: Liv Hausken (ed.), Thinking Media Aestetics, xxx 2013, 99, referring to: Henri Bergson, Matter and Memory, New York (Zone) 1991: 143
372 Mackenzie 2001: 244
373 David Linden, Das Spiel der "Brain Players. Rhythmen im Gehirn", in: Junge Akademie Magazin <Berlin> No. 4 (2006), 16 f. (17)

In the media-archaeological perspective on synchronization, there is no *a priori* pre-cognitive notion of time, but rather an inductive departure of analysis from actual technologies; the despotic signifier "time" is replaced a by a multitude of operative terms for signal events, such as "resonance" (from the mechanical tuning fork to the electronic resonant circuit); for digital systems. In computing, what is known as the motorical rhythm in humans, is replaced by the clocking of cycling units as precondition for storage-programmed algorhythmics (Miyazaki).

Chrono-technical violence: synchronization

There is a privileged (all the more deceiving, though) affinity between the human auditory channel, and the frequencies of nerve cell signaling, to technological signal processing. That means, from the engineering perspective, for discussing electronically based communication processes, it makes sense "to use auditory terms [...] like *feedback ... reverberation ... tuning*"[374]. "Sonicity" is a neo-logistic term for such an implicit message of "sound" as epistemological object which is primarily not its acoustic content but temporal signal form. From here results the analogy between sonic and media-technical articulations; their common denominator is arbitrarily structured, "dramatized" processuality.

This corresponds with the cybernetics assumption that synchronization in communication between machines (technical *and* mathematical) and animals can be (self-)controlled (Maxwell's "Governor") by time-critical negative feedback processes, as indicated by the subtitle of Norbert Wiener's 1948 publication *Cybernetics or Communication and Control in the Animal and the Machine*. The automatism of feedback differs from asynchronous "editing" of neuronal or technical memory such as film, sound, and video tape which "replaces the linear sequence of events *in time* with events juxtaposed in a time relationship established by the communicator"[375].

Classical cybernetic systems theory fell victim to epistemically seductive analogies between timings in technical media and in the human brain, like "clocking"; neurophenomenology rather accentuates the difference between technical und cognitive "timing".

[In the neurophenomenological investigation of the aesthetic experience of music (Helmholtz 1863), temporal structures from neuroimaging data can be analyzed most efficiently when using a neuro*dynamic* approach, whereas at present structure- and function-oriented neuroscientific approaches are dominant.[376]]

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374 Schwartz 1974: 23
375 Schwartz 1974: 23
376 Jin Hyun Kim, Shaping and Co-Shaping Forms of Vitality in Music: Beyond Cognitivist and Emotivist Approaches to Musical Expressiveness, in: Empirical Musicology Review, Vol. 8, No. 3-4, 2013, 162-172 (168)

Simultaneity *un*equals synchronization.[377] On the discursive level of symbolical time, the cultural concept of (global) history is a literary, narrative synchronization in the historiographical writing operation), an arbitrarily "agreed-upon chronology"[378]. Synchronicity, when applied to neural analysis itself, is a technological term, an artefact, since in the human brain or nerve oscillations, if at all, there is never exact clocking. Neuro-science and neuro-informatics separate.

Apart from the phenomenological analysis (Husserl / Bergson) of human cognition (and man-machine communication), there is the phenomenon of "emerging synchonization" *within* technological communication. In media theory, it is appropriate to call such processes "musical" in its archaic sense (ancient Greek *mousiké*), a symptom of which is the frequent use of implicitely "musical" terms for micro-temporal communication by engineers and mathematical theories of technical communication.

Audio-visual a/synchrocities

Phase-delayed signals, consisting of piezo-electric modules, served for the micro-synchronisation of PAL colour television RGB signals (von Bruch's "color clock"), just like the Acoutic Delay Line has been developed for the short-term maintenance of data words in the first electronic computers.[379]

This intra-technological delay differs from human sensory synchronization such as the audio-visual perceptional gap since the early times of sound film resulting from the different signal run times of acoustics and light. The media-archaeologically formative epoque of television broadcast technology, before magnetic video recording, just knew "live" transmission; in the meantime, the Marconi Company (GB, 1957) developed the Marconi Telerecording, a recording from screen by film camera with fast intermittent mechanism, while sound was recorded on a sychronized tape recorder with perforated recording material (double tape). In the Dolby Digital cinema system, digital sound information is coded in the space *between* the celluloid film perforation - while the parallel optical analogue wave form is still continuous. Digital sound recording corresponds with the discreteness of cinematographic projection again which, according to McLuhan 1964, rather relates to the machanical age than to electronics. But with the digitalization of the sound film, it becomes "silent" film again. A differential synchronicity arizes (an oxymoron); in traditional sound film, the acoustic track is 21 frames *in advance* of the actual image, for

377 See Niklas Luhmann, Gleichzeitigkeit und Synchronisation, in: ders., Soziologische Aufklärung 5: Konstruktivistische Perspektiven, Opladen (Westdeutscher Verlag) 1990, 95-130

378 John Durham Peters, Nonsimultaneity, in: same author, The Marvellous Clouds. Towards a Philosophy of Elementary Media, Chicago / London (University of Chicago Press) 2015, 91

379 See Alan Turing, The State of the Art [1947], in: idem, Intelligence Service, ed. Bernhard Dotzler / Frierich Kittler, Berlin (Brinkmann & Bose) 1987, 183-208 (esp. 186-192)

compensating the gap between acoustic (delayed) and visual signal run time in the moment of cinema projection.[380]

In his physiological laboratory equipped with time-critical measuring media, Hermann von Helmholtz detected that the run-time (speed of progagation) of signals in the motoric nerves of a frog counts around 24 meter/sec. This speed reminds of a synchronization problem within humans, when technical audio-visual synchronicity leads to irritation when confronted with physical signal run times in real nature; a lightning stroke is seen more immediate than the accompanying thunder is heard. For the temporal domain of human perception, the media psychologist Herta Sturm once experimentally explored that while every day perception which always includes a slight temporal delay of reaction involving a kind of inner speech ("subvokales Ansprechen"[381]), electronic media force their audience into immediate affective response. Immediate media interfaces deprive humans of their natural chance of delayed perception.[382] Does nothing or everything (a Jamesean "stream of consciousness") occur within this half-second?[383] With electronic signal immediacy, humans are deprived of this chance of delay[384]. The almost missing micro-temporal gap, is comparable to the essential "time of non-reality" (Norbert Wiener) in digital switching between zero and one.[385] There is asynchronicity in signal processing regarding humans on the one hand and electronic machines on the other, a difference in phase delay of signal transfer between technology and human physiology.

[Quasi-technical timing can be detected within human neuroprocessing itself, a kind of chrono-engineering. Pre-emptive activity is what apparently is stimulated in the pre-frontal cortex of the brain which does not simply react to incoming sensations but time-critically tends to anticipation, which is familiar from the difference between "live" and "real-time" signal transmission within communication media). The a-subjective and the a-human within humans (Gilles Deleuze) is a chrono-technical one.]

Time-critical media operations as implicit chrono-(syn)sonicity

380 See Siegfried Kracauer, Theorie des Films, Frankfurt (Main) 1960, 158, on "Synchronismus - Asynchronismus"
381 Hertha Sturm, Wahrnehmung und Fernsehen: Die fehlende Halbsekunde. Plädoyer für eine zuschauerfreundliche Mediendramaturgie, in: Media Perspektiven 1/84, 58-65 (61)
382 Herta Sturm, Fernsehdiktate. Die Veränderung von Gedanken und Gefühlen. Ergebnisse und Folgerungen für eine rezipientenorientierte Mediendramaturgie, Gütersloh (Verl. Bertelsmann-Stiftung) 1991, 55. See Uwe Sander, Die "fehlende Halbsekunde", in: Handbuch Medienpädagogik, Berlin / Heidelberg / New York (Springer) 2008, 290-293 (292)
383 A question posed by Brian Massumi, xxx
384 Herta Sturm, Fernsehdiktate. Die Veränderung von Gedanken und Gefühlen. Ergebnisse und Folgerungen für eine rezipientenorientierte Mediendramaturgie, Gütersloh (Bertelsmann-Stiftung) 1991, 55
385 See Claus Pias, Time of Non-Reality. Miszellen zum Thema Zeit und Auflösung, in: Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 267-282

Technical con-temporaneity differs from the human or social one. The synchronization in opto-electronic communication between the electronic Cathode Ray Tube camera and the corresponding receiver tube in television is time-critically delicate; otherwise there could be no mass media effect.

In cultural history, *posting* letters, phonographical recordings and cinematography has resulted in asynchronous communication, always in delay between sender and receiver, while simultaneous telephone and radio, in analogue days, have been - in implicit sonicity - "the mechanization of post-literate acoustic space"[386]. The specific "live"modality of broadcast media is synchronicity, ubiquity and differs from the temporal modes of digitally coded communication media which are based on intermediary storage on the micro-temporal level - therfore always delayed against the punctual "now".

Electro-technical synchonization in television image transmission and reception has been replaced by digital signal processing and transfer in realtime; the "live" transmission of images of the American bombing of Bagdad during the Iraq war in the 1990s by the TV channel CNN: "indissociable d´une nouvelle temporalité de la technique d´une autre rhythme"[387] which is, in fact, not musical but a function of algorithmic pixel calculation.

There is auto-synchronization in the circuitry of human / machine couplings, such as the Bosnia-Montenegrean *guslari* singers of epic verses are coupled to the one-string instrument (the *gusle*) not for the purpose of instrumental amusement of the audience but for servo-motoric feedback in creating the just-in-time prosodic rhythm of oral poetry. Software such as *The Amazing Slow Downer* allows for time-warping and -stretching of reference Jazz-musical recording without altering the pitch (beats per minute). This allows the students to re-inhabit the master solo, *to play in synchrony* with the (recorded) master, in the same frequency (be it in-phase or anti-phase synchrony). What has been the Harmonizer in Kittler's electronic times for time axis manipulation, nowadays is achieved by computational synchronicity; *predictive analytics* is algorithmically counter-calculating the present in real-time, like the Stealth Fighter computationally counter-corrects the physical distortion of the airplane shape which is necessary to deceive the enemy radar beams.

So-called *time-based media* in the traditional sense comprise literature and theatre, then grammophone, film and television. Media archaeology sharpens this notion by focussing on *time-critical* processes as well, where micro-temporal events are crucial for the overall process to happen at all: succeeding synchronization in telecommunication, and clocking within computer data circulation.

The term contemporaneity denotes rather the coming together of different times than simple being-in-the-same-time; technical synchronisation is *forced contemporaneity*. In early image telegraphy, the speed of transmission itself

386 McLuhan, "Five Sovereign Fingers Taxed the Breath" (1954)
387 Jacques Derrida / Bernard Stiegler, Échographies de la télévision. Entretiens filmés, Paris (Galiliée / INA) 1996, 83

had not been decisive, but rather the synchronization of sender and receiver[388], such as in time-critical electro-mechanical television signal generation and reception of *moving* images.

The time-criticality of synchronism is the moment when a technology is not simply an escalation (literally: further "step") of a cultural technique any more but becomes epistemogenic. In English, *isochronism* signifies "*equal in time*, or performed in *equal time*", while synchronism refers to "*occurring at the same time*, or having the *same period and phase*"; the difference is between ontological and operative times. In electro-mechanic archaic television, this resulted in the Automatic Tuning-Fork Synchronizer and the Toothed-Wheel or Phonic-Wheel Motor[389]; *nota bene*, once more, the use of "sonic" terms in engineering.

There is a difference between physical "presence" experienced by players in computer games (such as in LAN-parties), virtual "presence" (which is realtime calculation for sensomotoric synchronism as condition of the immersion experience in the game) and psychological "presence" in computer games.[390] When humans are loosely coupled to a gaming device, they are just contemporary with the machine action.[391] But tightly coupled to a computing device in gaming especially, and in ubiquitous computing generally, they become synchronized, subject to techno-mathematical time. In reverse, the machine is programmed in order to adapt to the human asynchronous rhythms, by means of the "interrupt" option which momentarily suspends machine action, waiting for the human input like the radar monitor equipped with a light pen at the CRT of the Whirlwind computer.[392] But temporal complexity *within* computing results in functional asynchronicities, such as the different rhythms (clocking) of cycling units.

There is implicit "musicality" in electro-technical timing-as-synchronization; time-critical media operations unfold in implicit chrono-sonicity. The very term "synchonicity" (like Aristoxenos' *chronoi* as time units of poetic prosody) already admits that there is no single transcendent parameter "time". "There is not `the time´, but only clock readings"[393]; instead of a despotic transcendent signifier called "time", *times* exist only as multitude. Once singular "time" is conceputally replaced by the description of discrete moments (Zenon "arrow flight" paradox, Aristotle's definition of *chrónos*), time measurements dissolve

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388 See Christian Kassung / Albert Kümmel, Synchronisationsprobleme, in: Albert Kümmel / Erhard Schüttpelz (Hg.), Signale der Störung, München (Fink) 2003, 143-165
389 Collins 1932 / 1991, chap. VII, 205
390 See J. Bryce / J. Rutter, In the Game - In the Flow: Presence in Public Computer Gaming. Poster presented at 'Computer Games & Digital Textualities', IT University of Copenhagen, March 2001; http://www.cric.ac.uk/cric/staff/Jason_Rutter/presence.htm
391 See Friedrich Kittler, entry "Flipper", in: same author, Baggersee, Munich (Fink) 20xx
392 See Pias 2002
393 Jürgen Ehlers, Concepts of Time in Physical Theories. Insights obtained and open questions, lecture at conference *On time*, 22-24 May, 2003, Einstein Forum Potsdam

(in accordance with Bergson's criticism) to position measurements. When "time" implodes, instead we discover, from media-epistemological perspective, the richness of micro-tempor(e)al multiplicities which unfold within high-technological processes.

The very term "synchronization" expresses the arbitrary, techno-logical enforcement of temporal actions, its antinym is "heterochronocity". The term points to the artefactual character of technical *timing* where "time" is not externally attributed to it as a referential quality.

Apart from the apparent "content" (result) of any synchronized action, its McLuhanesque "message" is that there is no time at all, which is only semantically attributed to transcendent signification which exits in culture as symbolic order only. When time comes into existence only by measuring (Aristotle), it is enforcing the symbolical on the real. The difference between symbolical time-ordering (such as narrative) and physical time is essential; different from thermodynamic (Boltzmann), informational entropy (Shannon) needs no term like "time" at all.

Resonance and "syntony"

[In his book Synchronicity. An Acausal Connecting Principle (Routledge and Kegan Paul, 1972), psychoanalyst Carl Gustav Jung defines the acausal connection of two or more psychic and physical phenomena, resulting from the archetype as *arché*: a dynamic which - like Leibniz' clock-driven "prestabilizing harmony" - governs human existence.[394]]

A self-performative form of synchronization is resonance. Martin Heidegger's use of terms from the sonosphere does *not* refer to explicit acoustics (as physical sound event) or to music as conceptual art form in culture, but rather to the implicit, epistemological meaning of sound as vibrating space. In the end of the 1930s, Heidegger defined human existence in resonance with ontological being.[395] Heidegger "understood" (German *vernahm*) the *implicitely sonic* nature of such vibrations - not in its acoustic sense, nor as an auditory listening experience. He had to make use of sonic vocabulary as a substitutional way of expressing the microtemporal structure of the "event" of being.[396]

"The resonance principle is not totally new or unique to electronic communication. It has always been an element in painting, music, sculpture, and, to a limited degree, even in print. However, resonance is not a more *operational* principle for creating communication because much of the material

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394 See https://en.wikipedia.org/wiki/Synchronicity, accessed July 13, 2017
395 "Das Wesen des Menschen [...] schwingt in dem Bezug des Seyns zu ihm. Diese Schwingung meint die unentschiedene Fülle des Entscheidbaren durch das eigene Innestehen des Menschen im Da-sein." (GA 70, 125)
396 Rainer Bayreuther, entry "Heidegger und die Musik", in: Heidegger-Handbuch, ed. Dieter Thomä], chapter 2.2 "Auf dem Weg zu einer Akustik des Seyns": 'Stimmung', 'Schwingung', und 'Harmonie' nach Sein und Zeit", 2013

stored in the brains of an audience is also stored in the brain of a communicator - by virtue of our shared media environment."[397]

The decisive technical configuration in the emerging epistemology of "radio" communication has been Heinrich Hertz' spark oscillator in correspondance with a "resonator". David Lodge later sonically called this electro-magnetically induced synchronization of distant objects "syntony", which in radio engineering resulted in the technical term *resonant circuit*.[398]

[Electronic tele-presence transforms the con-temporary into rigid signal synchronization. In terms of engineering, the electric *resonant circuit* enables radio communication, and only time-critical, exact synchronization of "live" television signal transmission and reception creates the impression of a steady image for the human eye. Only in the cosmic dimension, electro-magnet signal delay becomes visible in the distortion of *moving* targets like astronauts in Slow Scan Television transmission to the observer on earth.]

Electrotechnical synchronization takes place on several levels. Simple electric tuning is achieved by the *Schwingkreis* (resonant circuit), but "sympathetic electric resonance" is an "effect obtained when the electric oscillations which surge in a circuit send out electric waves of a given lenth and these strike a second circuit that is tuned to exactly the same frequency as the first one, so that electric oscillations will be set up in it"[399]. Damped and sustained oscillations" can be detected: "the energy of the oscillations that are set up in the aerial wire at the transmittiog station is converted into electric waves. When these strike the aerial wire of your receiver they are converted back again into electric oscillations. The receiver detects the *oscillations* that are set up in it, not the electric waves, though it is called an electric wave deetector [...]."[400]

Radio "Time Signals"

In the difference between the "synchronous" and the "simultaneous", the latter corresponds with McLuhan's notion of "acoustic space". Radio and wireless telegraphy reshaped each other. In World War One, at the Russian front, men listened to the spark acoustics of telegraphy as "radio entertainment". All electro-physical signals are (already) time-functions. In the media-archaeological "pre-history" (*epoché*) of radio before it became a broadcast medium, radio gas been a technology of synchronization: with the radio time signal, the medium message is its content as well, when listened to as communication - before, as a program format radio, this "figure" was pushed back to the "ground" (McLuhan). In 1912, the International Time Conference in Paris inaugurated the network of signalling stations with the Eiffel tower as center. *Watchmakers* once listened to its radio time signals.[401]

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397 Tony Schwartz, The Resonant Chord, xxx 1974, 25

398 See xxx Aitken, Syntony and Spark, 1976

399 A. Frederick Collins, Experimental Television, Boston (Lothrop, Lee & Shepard) 1932; Reprint Bradley, IL (Lindsay) 1991, 205

400 Collins 1932 / 1991: 216

401 See Horace Hurm's Ondophone (1914), referred to by Gabriele Balbi / Maria

There has been a re-entry of synchronization within time-keeping itself. With telegraphy in Switzerland, a message could be transmitted in "less than no time" - at least in terms of local sun-dial time. Since mid-19th century Bern local time became federal time in Switzerland: time sent as telegraphic signal ("Einheitszeit"), used in coupling with railway logistics. For other contexts, local time remained partly intact.

The time-critical electronic television image

The earliest known recording from a television program - the revue *Looking In*, performed by the Paramount Astoria Girls on the BBC Baird television system (30 lines) in April 1933 - has been recorded by an enthusiastic amateur on his Baird Phonovision system equipment on aluminium disc. Recently processed and restored by digital filtering, the key to clarity is the neuronal perception of movement itself. Any reproduction of one of the 30-line television broadcast as photographic stills in a printing medium gives a wrong impression of what had been actually seen. Here the time-critical comes in, since printed records (be it texts, be it images) miss a crucial element: time.

"A single frame of the Paramount Astoria Girls may be crudely recognisable, but when seen as a moving dynamic television image, the girls come to life before our eyes. [..] it has much more to do with what we perceive than what is there in pixels, lines and frames. What we are experiencing is not the detail that the eye sees, but the recognition of movement that the brain sees."[402]

Digital synchronicities

The modelling of human neuronal synchronization, since the cybernetic brain-computing metaphor by McCulloch / Pitts and von Neumann, is grounded in the very materiality of digital computing. The fundamental unit of memory, the electro-magnetic relay, for electronic ingineers, seemed "naturally adapted to the binary system" since they did not attempt to measure gradations of charge at a particular point but were "content to distinguish two states"[403] - which makes all the difference to the time-functional classical black & white television scan line, and to analog computing. The flip-flop as truly binary device provides for the rhythm. Magnetic wires or tapes or acoustic delay line memories recognized "the presence or absence of a pulse or (if a carrier frequency was

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Rikitianskaia in their lecture "The Age of Synchronization", at the conference *Zeitregime und Geschichtswissenschaften* of the Swiss online portal *infoclio.ch*, October 14, 2016, in Bern
402 Donald F. McLean, Restoring Baird's Image, London (The Institution of Electrical Engineers) 2000, 211 f.
403 Section 5.2., in: Arthur W. Burks / Herman H. Goldstine / John von Neumann, Preliminary Discussion of the Logical Design of an Electronic Computing Instrument, in: John von Neumann, Collected Works, vol. 5, ed. by A. H. Taub, Oxford (Pergamon Press) 1961, 34-79; reprint in: Swartzlander (ed.) 1976, 221-xxx (227)

used) of a pulse train"[404]. All of the sudden, beyond the phenomenological notion of the continuous endurance of time (Bergson), computer time actually *sounds* different.

The core media-epistemogenic act in interfacing the physical world to numerical computing is analog-to-digital sampling. This signal processing basically consists of an *a priori* synchronisation. By high-frequency clocking (the 44.1 kHz standard for audio, such as for Compact Discs), the signal is first of all time-discretely sampled, bevor being evaluated ("quantised") in terms of information (measured in bit-depth).

In such concrete chrono-poetical scenarios, media archaeology identifies the digital "shaping of time" (George Kubler). The sample-and-hold mechanism (before the signal actually gets digitally quantised) "stores" its records only for a fraction of a millisecond. Condensers figure among the smallest electro-physical storage elements, and combined with transistors they function as micro-memories here. The electronic sound slice is a temporal being in such electronic circuits, not punctual, but a suspended instant of time as voltage.

"Social" media synchronization

For radio amateurs, head-phone signal reception had been strictly individual; synchronization of collective reception has a strict electronic condition: the vacuum tube (later transistor) for amplification to operate a loudspeaker.

In times of "social media", the traditional synchronisation of society by radio or TV broadcasting (the simultaneous reception in mass media culture) is replaced by *temporary* synchronisation ("Flash mobs").

The so-called Community Memory project in the San Francisco area has been an early attempt to place networked computer terminals in public places, a telephone-line, Modem- and computer-based social network which emerged around 1970s, figuring centrally a Time-Sharing main frame computer (the SDS 940). What has been "social interaction" among individuals in sociological terms has become cold synchronization.[405] The media-archaeological condition for enabling such *online* social synchronization has been the magnetic core memory in the central main frame computer. This binary grid is no metaphor on neuronal data processing any more.

TRACING TEMPOR(E)ALITIES IN THE AGE OF MEDIA MOBILITY[406]

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404 Burks et al. 1961 / 1976: 227
405 See Stefan Höltgen, "All Watched Over by Machines of Loving Grace". Öffentliche Erinnerungen, demokratische Informationen und restriktive Technologien am Beispiel der "Community Memory", in: Ramón Reichert (ed.), Big Data. Analysen zum digitalen Wandel von Wissen, Macht und Ökonomie, Bielefeld (transcript) 2014, 385-403 (386)
406 Parts of this text relate to a former keynote lecture on occasion of the symposium *Tracing Mobility – Cartography and Migration in Networked Space*, November 26, 2011, Haus der Kulturen der Welt, Berlin

[abstract]

New forms of tempor(e)alities coemerge with the geospatial aspect in media mobility. Though mobile devices predominantly communicate by the visual interface, on its technologically operative level it is rather akin to radio in terms of the electro-magnetic spectrum, and to the binary alphabet of algorithmicized codes. The media-archaeological approach to geospatial "memory" therefore analyzes data transfer from distributed storage agencies and interactive "online"-citizenship. Geospatial media analysis (navigation, mobility, orientation) is necessarily accompanied by micro-temporal analytics. Digital communication of cultural memory transforms from the traditionally space-based archives (its "tectonics") into dynamic up-dating in high frequency steps; site-specific memory is substituted by media-specific storage, recall and transfer. Symbolic urban cityscapes become a phenomenal function of underlying media infrastructures which take place at the emptiness left by former cultural and collective memory.

Keywords: media temporalities; memory vs. storage; Media Archaeology vs. Media Phenomenology; infrastruture; topological graphs; smart online-citizenship, chrono-sphere

Introduction

When visitors to Italy in late 18th century, during their educational Grand Tour, finally arrived in Rome, the capital of their classicist dreams, they were frequently faced with a disappointment. The ancient ruins were much less sublime than the preivously known reproductions (such as Piranesi's notorious engravings) had suggested, and it took several days of rereading the texts of ancient authors to readjust the optical perception, restoring the symbolic order within the real city by the philological filter. Nowadays, mobile communication devices with their dominant interface, the screen, immediately adjust locations to predominantly visual or textual (rarely auditive) information from the Web data repositories. Within such globally extended urbanity, memory is not derived from individual or social recollection any more (bodily and psychically "interiorized" - *Erinnerung* - in G. W. F. Hegel's term), but from storage located in distributed computer farms. Geospatial memory for the user is predominantly mediated to the eye by the dominant interface of the micro-computational "smart device" which, in the field of perception, becomes almost identical with its visual terminal itself. Memory forms and enters geospatial perception primarily through this technical format.[407] As pointed out in Marshall McLuhan's media theory, this privilegization of the visual information channel is only superficially image-driven but an effect of the ancient Greek phonetic alphabet which directed information transfer from mouth and ears (oral speech) to the eyes: reading alphabetic texts. The essential alphabetic information, though, can not easily be read any more by most users in urban

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407 See See Nanna Verhoeff, Mobile Screens. The Visual Regime of Navigation, Amsterdam (Amsterdam University Press) 2012 (with thanks to Jon Inge Faldalen, scholar of "imagenesis", at Oslo University, Norway, for that reference)

mobile computing, since it is hidden within the "smart" devices as alphanumeric code. Critical media-philological analysis must now recede into the operative level below the miniature mobile "phone" screens, which is codes and protocols. "Geospatial media has saturated cityscapes" <cfp>. But the hidden geospatiality, operative within such media, is not about geographical spaces any more, but about geometries of processual ICs and storage chips, and spaces in Internet traffic are organized as topological graphs. Any "digital" communication results from a rigorous encoding of analog signals into the data matrix. Such data do not migrate any more but are copied, compressed, decompressed, and identically reproduced. Geography becomes a phenomenological metaphor.[408]

Spatio-temporal media analytics

Geospatial media, understood in its technological sense, relate to both the physical positioning of mobile communication devices, and the large scale computational analytics of data emanating from such micro-processor based tools. Different from passive immobile communication media like home Television sets or personal computers (or servers at institutional locations) for processing of Web-based information, or early "mobile" communication technologies like the analog transistor radios (except bi-directional ham radio communication[409]), digital mobile media become senders themselves - thereby vulnerable to analysis as well as interception. Making use of the Global Positioning Service means being positioned (geospatially monitored) at the same time. Portable communication devices can capture and process geospatial information in the both geographic and electromagnetic "field". In GPS, which is based upon a network satellites to provide precise coordinate locations, the effective computation is not only space- but also time-based, calculating spatial location from the ratio of micro-temporal distances in signal transfer. Geospace has become time-critical itself, interlacing the conventional separation of perceptual "time" and "space" into a spatio-temporal data tissue.

Software environments like Google Earth which have become available to users of mobile commubication devices, result in new kind of "spheres". After Teilhard de Chardin had introduced the neologism "Noosphere" in his *Cosmogenesis* as the "thinking envelope of the biosphere", that is, the human sphere of reflection and consciousness[410], Marshall McLuhan adapted this concept to the

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408 See Hartmut Winkler, Geometry of Time. Media, Spatialization, and Reversibility, lecture given at conference *Media Theory on the Move*, Potsdam, 21 - 23 May, 2009, preprint http://homepages.uni-paderborn.de/winkler/hase_e.pdf, accessed October 10, 2017

409 Amateur radio (*alias* ham radio) "describes the use of radio frequency spectrum for purposes of non-commercial exchange of messages, wireless experimentation, [...] and emergency communication", different from commercial broadcasting, or professional two-way radio services; = https://en.wikipedia.org/wiki/Amateur_radio, accessed October 17, 2017

410 See Georgy S. Levit: "The Biosphere and the Noosphere Theories of V. I. Vernadsky and P. Teilhard de Chardin: A Methodological Essay. International Archives on the History of Science/Archives Internationales D'Histoire des

"acoustic space" of electronic communication media environments. But the turingmachine (*alias "*computer") from 1936[411] operates within a sphere of computability which is different from de Chardin's human mind-based "noosphere", or the electromagnetic "acoustic space" in McLuhan sense, defining everything that could possibly be executed by digital machines. The algorithmic technification of the calculating human mind extends to a geospatial and multitemporal scale.[412]

Geospatial technologies map both human and nonhuman mobility (weather, for example) into computational topologies. Computational tools for mapping and analyzing georeferenced data, based on the Global Positioning System, detect geospatial patterns on the ecological level just like mighty search engines in the Internet detect clusters of communication behaviour by humans. All of the sudden, the obscuring metaphor of "cloud computing" becomes very concrete. What used to be called cultural or social memory turns into distributed data storage. This non-human "memory" is obscured by the metaphor of "Cloud computing" which relies on *sharing computing resources* rather than having local servers or personal "smart" devices to handle software (abbreviated to "Apps"). In "cloud computing", *the cloud* "is used as a metaphor for '*the Internet*'" as such, with its different nonhuman agencies such as server farms for data storage.[413] Cloud-based geospatial computing already practices this different kind of "memory"; data can be collected in the field using mobile devices and then transmitted to cloud-based servers for further processing and ultimate storage; geospatial information can be made available to connected mobile devices via the "cloud" architecture, allowing access to vast databases of geospatial information "anywhere where a wireless data connection is available"[414].

While the art of cartography, even when augmented by photography and trigonometric measuring, has primarily remained a cultural technique, that is: bound to operations of the human hand, computer- and satellite-based geospatial mapping is not simply a new dimension but a new media-epistemic quality. Apart from collecting and storing geospatial data, it is their algorithmic processing which endows them with mathematical intelligence, culminating in the geographic information systems (GIS) which process data based on their precise location on earth and beyond, (hence already becoming "cosmospatial").[415]

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Sciences", 50 (144), 2000: p. 160–176

411 Alan Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, in: Proceedings of the London Mathematical Society (2), vol. 42 (1936), 230-265

412 An argument developed in the Master thesis by Thomas Nückel, Berechenbarkeit als Sphäre digitaler Medien [Computability as the Sphere of Digital Media], submitted Winter term 2016/17, Humboldt-University, Berlin, Insititute of Musicology and Media Studies (now online at e-doc server of Humboldt University)

413 https://www.webopedia.com/TERM/C/cloud_computing.html, accessed October 17, 2017

414https://ipfs.io/ipfs/QmXoypizjW3WknFiJnKLwHCnL72vedxjQkDDP1mXWo6uco/wiki/Geospatial_analysis.html, accessed October 17, 2017

Geospatial analysis is applying statistical analysis and predictive analytics to data which has a geographical or spatial aspect, operated by software capable of rendering maps to such datasets (geomatics).[416]

The GIS has become "intelligent" by "deep learning", that is, in terms of radical (instead of nostalgic) media archaeology, it grounds in genuinely mathematical operations, such as vector-based map overlay (combining two or more maps or map layers according to predefined rules), or raster-based GIS, widely used in the environmental sciences and remote sensing, involving algebraic operations.[417] Spatial analytics is based on statistical operations, but different from traditional mathematics, it becomes dynamic by being incorporated into the electronic circuitry of micro-processors. Thereby geospatial media, both as subject and as application, apply to spatially data that vary *over time*, with the time series being at the core of cybernetic analysis.[418]

While the user interface content of geospatial analysis still looks like integrated into the conventions of screen culture, its real media message goes beyond the traditional image, and become diagrammatic iconity instead. 2D and 3D mapping operations and spatial statistics analyse the properties of physical surfaces, such as gradient, aspect and visibility, and surface-like data fields. Geovisualization turns analysis into imaging synthesis, making sublime data sensible to human perception again on the phenomenal level: maps, diagrams, charts, 3D static or rotating views, providing animations and fly-throughs, and spatio-temporal visualisations.[419]

Dis-locations: Diagram and topology instead of "mobility"

When the act of communication transfer becomes a cluster of technically calculable numbers, mobility itself dissolves from Newtonean physical spaces into geometric Cartesian space - that is, data configurations which are closer to Iannis Xenakis' stochastic music in its temporality than to conventional space in visual culture. Norbert Wiener's *Cybernetics* (1948) analyzed how the goal- and target-orientated trajectory (mobility) is replaced by statistical probabilities. With digitally coded transmission, the trajectory (*telos*) of "tele"communication is being effaced in favour of a mathematical (chrono-topological) immediacy - which makes all the difference between "live" transmission and "realtime" calculation, leading to a techno-logical proximity instead of mobility as energetic movement. The structural essence of mobile digital communication and the World Wide Web is not primarily the transmission of documents (the "moblity") but its hypertextual and hypermedia link structure - a dynamic topology rather than a static cartographic topography. What is essentially transmitted and installed are symbolical machines - algorithmic "Apps". The physical location of texts or books at a certain place (such as the traditional

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415 See https://www.aaas.org/content/what-are-geospatial-technologies, accessed October 16, 2017
416 https://en.wikipedia.org/wiki/Geospatial_analysis, accessed October 16, 2017
417Ibid.
418Ibid.
419Ibid.

library) is replaced by topological space and a grid of computer servers to host them. Such a location is both geophysical (in terms of hardware) and conceptual (in terms of logical units). Instead of imposing library-orientated terminology, a media theoretical analysis of the World Wide Web adapts to the dynamism of the medium. Within that dynamic context, algorithmic orientation (such as performed by search enginges) is not about mobility but about statistics, vectors and graphs.

Media-phenomenological vs. media-archaeological analysis of geospatial media memory

City streets are no longer simply physically and bodily conquered but navigated along metadata, shaped by web infrastructures. The cybernetic (that is, system theoretical) assumption persists: Users, once their physical / bodily spatial environment is actually coupled to virtual (that is, calculated) environments by computational interfaces in the real-time "online" mode, gets (post-)human at the same time - with the prefix "post" literally referring to data transfer which technologically preconditions such a double-bind *situation*. Implicitely, Claude Shannons *Mathematical Theory of Communication* (1948) still has more to say to "what actually happens" here, than most media sociologies. While the media-phenomenological approach primarily investigates the affects and effects of such mobile communication media on individual and collective memory, it requires a complementary analysis which concentrates on the very geospatial infrastructures - the "conditions of possiblity", in the Kantean sense. The cognitive *a priori* of "time" and "space" itself is replaced by the tempo*real*, a cluster of differentiated spatio-temporal infrastructures in data traffic. What necessary gets into focus for critical analysis is the grid composed of both topological (rather than geographical) and micro-processing agencies: the storage lattice for data and its micro-delays in signal processing.

Media Archaeology, which is both a field of study and a method of inquiry, aims at striking sparks critical insight from *from within* such technological knowledge, against which so-called "social media" effects turn out rather epiphenomenal. As research method, it is less a discourse analysis of media phenomena, but rather concentrates on their grounding in material and / or logical artefacts. As a method of media analysis, it addresses the structural (material *and* logical) preconditions of media practice, which corresponds with what Michel Foucault's *Archaeology of Knowledge* once named as *l'archive* (in the French original from 1969), such as Internet protocols[420] or the von-Neumann-architecture of digital computers. In that sense, Media Archaeology is technocentristic, that is: machine- and code-centered indeed. Against the opaqueness of micro-technology hiding behind the flat screen of "smart phones" in communication, Media Archaeology intends media-awareness by making transparent its proverbial Black Box. While media phenomenologists rather analyze how various media appear to the human cognitive apparatus, that is, to the mind and senses, media archaeologist "describe the non-discursive practices of the globalized techno-cultural archive"[421]. Imagery and

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420 See Alexander Galloway, Protocol. How Control Exits after Decentralization, Cambridge, Mass. / London (MIT) 2004

data collected from satellite- or airborne camera and sensor platforms has already resulted in nonhuman Remote Sensing.

The "mediated experience of cities" <cfp> by humans is the focus of media phenomenology, but below all this, the practices of "geospatial memory" are time-critically ("post"-)structured by high frequency-clocked media technologies. While the human user is developing new perceptual and conceptual modes of geo- and chronolocation, he or she is geo- and chrono-located by the devices he / she uses itself, resulting in large data banks and predictive data fields hosted by the computing server farms or providers like Google, Facebook, and the NSA. Geospatial individual and collective "meaning-making" becomes of function of the digital communication devices and "apps"; its underlying episteme is utterly techno-mathematic.

"Radiocity"

There is a media-epistemological ground behind the surface figures of mobility. This first of all concerns the physical nature of "motion"[422] and its secondary re-entry in techno-cultural emanations. Marshall McLuhan, around 1960, remarked that electricity and electronic devices create rooms without walls[423] and a "media field"[424]. Looking through the media-archaeological magnifying glass, under the surface effects of social mobility, we detect the migration of electrons in cables and in micro-chips. Electronic speed in wireless communication does not rely on mechanical vehicles any more; it moves even within the vacuum - be it the Thermionic Tube or the empty space of the universe. Electro-magnetic waves (the literal meaning of "radio") are being propagated almost unbound to matter or energy.[425] Inspired by this media-epistemological insight, the notion of a temporal "field" ("Zeitfeld", as expressed by Edmund Husserl's phenomenology) has replaced the mechanical idea of linear time by cloud-like temporal figurations.

The traditionally more or less spatial notion of the "city" is increasingly accompanied by parallel manifestations of dissipated net-citizienship, which is infrastructually based on radioCITY in terms of obiquitous pulse-modulated

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421Kjetil Jakobsen, Anarchival Society, in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154 (141)

422"Bewegung ist Aenderung der räumlichen Verhältnisse <...> wenigstens zweier materieller Körper gegeneinander" : Hermann Helmholtz, Abhandlungen zur Thermodynamik, edited by Max Planck, Ostwalds Klassiker der exakten Wisenschacten, vol. 124, Leipzig 1902, 6

423Marshall McLuhan, manuscript entitled "Grammars of Media", NAEB Papers (University of Wisconsin), Box 66, Folder 9, as quoted in: Josh Shepperd, Medien Miss-Verstehen. Marshall McLuhan und die National Association of Educational Proadcasters, 1958-1960, in: Zeitschrift für Medienwissenschaft vol. 5, no. 2 / 2011, 25-43 (40)

424 Marshall McLuhan in a letter to the NAEB director Harry Skornia, December 16, 1958, quoted ibid. (41)

425 W. T. Runge, Elektronische Geschwindigkeit ist keine Hexerei, in: radio-tv-service Nr. 77/78 (1967), 2895-2899 (2895)

radio waves for mobile communication devices in wireless data transfer processed by individual micro-processors like Smart Phones. After the recent or imminent death of analog AM and FM radio, there actually is more "radio" than ever: the pulse-modulated, digital rhythms of impulses, processed by algorithms. The extension of the radio "empire" has always already transcended the geospatially fixed location ("region"). With digitally coded radio transmission, waves are being replaced by impulses (samples) which can then mathematically be pre-calculated. In Pulse Code Modulation, the spaces inbetween pulses can then be filled by delayed bit streams. Thus interpolation replaces mobility. In "tele"communication, all of the sudden, spatial distance (the *a priori* of mobility as transfer) does not count any more, since it is being replaced by the temporal act of calculation. Analog frequency multiplexing and digital time multiplexing as forms of multiple use of communication channels are based on the time-critical interlacing of signals.[426]

In so-called *cognitive radio* "time hopping" means the intelligent use of short-time vacancies and time slots.[427] Time-discrete operations increasingly replace the traditional electronic signal transfer in the broadcasting world. Analog radio signal reception differs from the dis-locational positioning in data-based "mobile" communication which is logical addressing ("URL") instead of analog broadcasting. Classic radio mobility once culminated in the technoculture of so-called "World Receivers"; at almost any point on the earth, a German citizen could receive the German-speaking program of Deutsche Welle. Now this access is being replaced by the *online* service of Deutsche Welle which is no wave ("Welle") any more but streaming data *via* Internet access by cable or by wireless LAN.[428] Advertising for that dramatic change in radio culture, the Deutsche Welle service claims that in the Internet radio information can be multi-medially coupled. Behind that phenomenological, user-interface-based aesthetics, the hypertextual link reigns - a structure completely different from classical electro-magnetic braodcasting. The director of Deutsche Welle, in his farewell-speech to the analog German-speaking program on October 29th 2011, advertised for the "radio" portal www.dw-world.de: "Stay tuned, search for new ways of access."[429] This is already the language of nonlinear connectivity, implying that radio already has gone. Radio "on demand" and as download by Podcasting is not tuning (mobility) between radio frequency channels any more (bandwiths) but rather between temporal channels even if declared "live stream"; the physically and temporally authentic analog "live" signal is being replaced by realtime calculation) - deconstructing linear time. Digitalization (that is: mathematization) indeed introduces a discrete time-hopping, discontinuous mobility, moments instead of trajectories. Algorithmically precalculated transmission actually swallows the time of transmission itself, just like in the macro-temporal sphere the culturally emphatic notion of "tradition" is currently being re-placed by a synchronous,

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426 See H. Raabe, Untersuchungen an der wechselzeitigen Mehrfachübertragung (Multiplexübertragung), in: Elektrische Nachrichtentechnik vol. 16, no. 8 (1939), 213-228 (213)

427 http://de.wikipedia.org/wiki/Time_Hopping

428 The regular German-speaking program of the German world-wide radio Deutsche Welle has been ending as linear broadcasting (analog short wave) on the night from 29 to 30 October 2011.

429 Bettermann: "Bitte bleiben Sie uns verbunden, suchen Sie neue Zugangswege"

even historistic "immediate" (Leopold von Ranke) access to the archivised past(s). The elementary scheme of communication is not transmission from point A to point B any more, but rather the modification of a temporal (momentary) configuration.[430]

Decades ago, the Sony "Walkman" has been a symbol of mobility in carrying around recorded sound individually, as a kind of *temporally mobile* independence from music reception by transistor radio. The cassette has been succeeded by the mp3 player (the I-pod), but the current shift towards cloud computing replaces this mobility by dynamic access to the (media) archive itself; smart devices access sound files stored in local networks (moving and navigating *within* the archive).

Local memory? a techno-archival retro-effect

Memory literally gets in motion.[431] Instead of going to local archives for research in previous times, scholars can now move *online* within digitized archival records not only at home (without moving) but at any place. The Internet is not an archive but a Protean dynamism, characterized by change rather than endurance. Permanent up-dating (or up-dating in permanence) has been the temporal aesthetics of modernism already. This corresponds with the shift of emphasis from the final archive to temporary, literally inter-mediary storage. In museums, the institutional keepers of material cultural memor, the traditional permanent exhibition is increasingly being replaced by temporary exhibitions; Bergsonean *durée* turns out as a function of frequencies. Memory has become a function of immediate access to data storage centers, while in turn, the present becomes radically temporalized (even micro-archivized) in dynamic, realtime data processing. Human perception of the present city is immediately linked to data storage and processing, shrinking individual or collective memory to a surface effect. Identities, by technically mediated environments (whether through writing, cinema or digital media), become ephemeral in times of immediate transfer of coded information. Formerly place-bound local memory sites are superseded by new media environments, like the fashionable projection of images or texts on architectual surfaces during "enlightened" city night shows. Immobile matter itself becomes a function of the mobile screen. In a psychic counterreaction, the global reach of web-based and mobile communication devices is accompanied by a nostalgic desire for local roots. In times of ubiquitous mobility both for bodies and for communication devices, a retro-active longing for "citizenship" or community-building arises on the symbolic (computational) and imaginary (media user) level.

Ubiquitous computing leads to what Ray Hammond predicts in his vision of *The World in 2030*: "always on, always connected, everyone to everyone,

430 Pierre Lévy, Die Metapher des Hypertextes, in: Claus Pias / Joseph Vogl / Lorenz Engell et al. (eds.), Kursbuch Medienkultur, Stuttgart (DVA) 1999, 529 [Les Technologies de l´intelligence. L´avenir de la pensée à l´ère informatique, Paris 1990, 78-82]
431 See Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010

everything to everything, always and everywhere"[432] - which has not only a spatial but as well a temporal dimension. The user is connected to a chrono-sphere defined by the (meta-)medium and is allowed to jump in temporal layers provided by the *online* archive. To be suspended from unbiquitous mobility is the true luxury in today's temporal economy - the katechontic impulse of pausing, of deferal. Instead of setting geospatial memory in motion, moments and locations of resisting permanent change is retro-effectively gaining momentum.

Media-archaeological foundations of mobile communication: from the electro-magnetic field to the techno-mathematical matrix

Movement is predominantly associated with linear migrations and nonlinear dislocations in space. In cultural analysis, it is frequently taken in its discursive meanings, in the sense of "cultures of mobility".[433] Even the most exact analysis of mobility seems bound to discursive metaphors. Literally, *metaphora* itself is the Greek term for transport vehicles, and so-called "buses" communicate data between processing and register units within a micro-chip.

In H. D. Wells' scientific fiction *The Time Machine*, travelling between past and future still takes place in terms of mobility, with a chrono-mobile vehicle moving *within* (endophysical) time. Nowadays, time itself is being moved within the mediasphere. This new way of being-in-time started with the invention of photography fixing and preserving a unique moment in time, and continued with phonography which can re-play voices of the dead, escalating with kinematography which allows for the reversal of the entropical, thermodynamically defined arrow of time and stimulating slow respectively fast motion. Time became electronically manipulable by the STOP / PLAY and REWIND/FF keys in audio and video recording on magnetic tape; phase shifting of oscillations in electronic synthesizers is known from electronic music.[434]

The video artist Bill Viola in his essay on the "sound" of electronic images pointed out the techno-mathematical spatialization of former time-signals, "the current shift from analogue's sequential waves to digital's recombinant codes" in technology.[435] The equivalent in computing is the concept of *time sharing*, the geometrization of the present itself. Significantly, in digital technology the term "field" which derived from the analogous, steady movements within electro-magnetism itself transforms into the description of a discrete configuration, as expressed f. e. in the "Field Programmable Gate Array" (FPGA) for re-configurable hardware in micro-processors. The dynamic field becomes a digital matrix, transforming "mobiity" into addressability.

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432 Ray Hammond, The World in 2030, Paris (Editions Yago) 2007, 66

433 See *Berliner Atlas paradoxaler Mobilität*, edited by Friedrich von Borries in cooperation with the initiative ÜBER LEBENSKUNST, a project of Kulturstiftung des Bundes in cooperation with Haus der Kulturen der Welt, Berlin (Merve) 2011

434 See Karlheinz Stockhausen, ... wie die Zeit vergeht ..., in: Die Reihe. Information über serielle Musik, Heft 3, Universal Edition, Wien / Zürich / London (1957), 13-42

435 Bill Viola, The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (eds.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54 (47)

Today, the idea of the central computer with remote shared access turns upside down by the concept of "cloud computing". The Internet is not restriced to being an extension of interconnected central computers ("servers") which are being accessed from immobile homes, but mobile communication devices themselves have become small computers to be connected to network access points and areas. The "Internet of things" and ubiquitous computing result in a re-entry of mobility as a secondary effect of a topologically "immobile" grid. Data navigation within topological space (or rather networks) might still be called "mobility", but its nature has transformed completely from physical location to geometrical graphs and logical relations (in mathematical terms), from analog tele-communication to computational mobility (even if wireless communication, technically, is still "radio"-based).

With digitally coded radio transmission, waves are being replaced by impulses (samples) which can then mathematically be pre-calculated. In Pulse Code Modulation, the spaces inbetween pulses can then be filled by delayed bit streams. Thus interpolation replaces mobility. In "tele"communication, all of the sudden, spatial distance (the *a priori* of mobility as transfer) does not count any more, since it is being replaced by the temporal act of calculation. Analog frequency multiplexing and digital time multiplexing as forms of multiple use of communication channels are based on the time-critical interlacing of signals.[436]

Computational devices generate new temporal figures - a true technopoetical chronomobility based on nonhuman agencies of delayed memories and dynamic intermediary storage. Computational mobility ultimately results in ephemeral tempor(e)ality which is characteristic in current high-frequency e-trading; the financial market is defined by radical time-critical indexicality; even nano-second delay induced by glass fiber cables literally counts.

"Mobility" - a term of modernism

The notion of "mobility" rather belongs to the discourse of modernity; in a famous analysis on occasion of a new railway line connecting Paris to another Franch city Heinrich Heine once remarked (just like Paul Virilio's dromology later) that space is killed by speed. Mobility has been a paradigmatic feature of 20th century modernism. With the mobilization of formerly symbolically ordered time, a temporal horizon called historicity opened where the forthcoming future could be anticipated as "future in the past" already. Martin Heidegger in 1934 identified the temporalization of time itself "Zeitigung der Zeit" instead of reducing it to the parametrical "Faktor *tempus*"[437]. Within that frame of perception, two temporal figures dominate the scheme of movement: the trajectory and the discontinuous jump.

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436 See H. Raabe, Untersuchungen an der wechselzeitigen Mehrfachübertragung (Multiplexübertragung), in: Elektrische Nachrichtentechnik vol. 16, no. 8 (1939), 213-228 (213)

437 Martin Heidegger, Logik als die Frage nach dem Wesen der Sprache (lecture summer term 1934), ed. Günter Seubold, (vol. 38 of Gesamtausgabe) Frankfurt / Main (Vittorio Klostermann) 1998, 101

In sociological perspective, the mobilization of collective energy (such as migration) corresponds with the technical mobilization (physical transport with the appropriately called auto-mobile) and the mobilization of communication by almost immaterial signals on the electronic level. Material mobility starts with the steam-engine based railway, and immaterial mobility with telegraphy as currently presented in the exhibition *Car Culture*, appropriately sub-titled: *Medien der Mobilität*, at ZKM Medienmuseum Karlsruhe (June 2011 until January 2012). The network of material cables for "landline" telephone communication has been replaced by radio communication networks.[438] Physical mobilization like railway traffic has been accompanied by the parallel mobilization of symbolical communication embodied in electronic "tele"communication media (Samuel Morse's telegraphy in 1844, killing distance both in space ("tele") and in time "live") - telecommunication, "live" transmission. But in the age of digitized broadcasting and digital communication engineering, the term for the current end-user device, the literal "mobile" phone, itself becomes a nostalgic metaphor.

Synchronization has been the technical essence of success in modernist communication between sender and receiver. But today, reception is anticipated by the sender. The immediacy of "live" transmission is being replaced by "streaming media" which is based on asynchronous transmission, buffering data signals in micro-memories, thus causing minimal delays (due to calculation) even if it is not noticable by slow human senses any more. What Jacques Derrida once claimed as *différance* for sequential writing, here turns techno-mathematical. Coded time itself becomes an "artefact".[439] The so-called delay time (caused by the inertia of matter) and run time *(alias "*dead time")* is the temporal interval between a system input and its response at the output. As transport time, this refers to micromobility on the media-archaeological ground level of electronic circuitry. "The time it takes for material to travel from one point to another can add dead time to a loop. <...> The distance may only be an arm's length, but a low enough flow velocity can translate into a meaningful delay."[440] This form of a temporal *inbetween* is central to the notion of media itself. Aristotle once discovered in the echo phenomenon the resistance of the transmission channel air to sound, which he coined *to metaxy* - a term whose Latin translation by scholastics in medieval times turned into the *medium*. Time in communication itself is "medium" in Claude Shannon's functional definition of the channel of transmission.

Time hopping. Time "travelling" (in) the World Wide Web

Tracing mobility, understood literally, recalls the methods of technical observation and mathematical calculation of movements. On a micro-level, such mobility has been traced with the detection of the "Brownean Motion" in nineteenth century. But this tracing is not cartographic any more (which still

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438Franz Pichler, Mobile Kommunikation per Funk. Von Heinrich Hertz zum handy Netz des Mobilfunks, Linz (Universitätsverlag Rudolf Trauner) 2011, 1
439 Jacques Derrida / Bernard Stiegler, Echographien. Fernsehgespräche, edited by Peter Engelmann, Vienna (Passagen) 2006, 13
440 Doug Cooper, Dead Time Is The "How Much Delay" Variable; *online* http://www.controlguru.com/wp/p51.html

adheres to iconic perception), but with mathematically averaging myriads of elementary movements of particles (like the electrons in the Thermionic tube). Norbert Wiener described such motion as "ergodic" - which is invariant across a temporal trajectory in its stistical behavious. Within such stochastic analysis, the singule individual particle does not count any more - just like in information/communication/entertainment spheres the mobile subject is surveilled as nonlocated address. A bio-cognitive gap opens: While human bodies undoubtedly still move in space and time in mobile ways (the everyday experience), connected to digital media humans are coupled with another, media-inherent time and space. Techno-logical addressability replaces physical or biological identity. Technical media record such movements, while mathematics (statistical and/or stochastic analysis) tries to make sense of apparently random movements. Technical tools of time axis and memory manipulation have been known since phonography, cinematography and video art, in technical engineering and aesthetics, performing micro-temporal operations of signal migration. Such figures of analog time-shifting are now challenged by nonlinearity. Metaphorical data "flow" and "streaming media" replace the static monument. Knowledge has always been in motion, but now it becomes time-critical. Chronology becomes ephemeral; short-time finality is taken into account from the beginning. Para-textual temporal remarks like "last modified" and "accessed" in the online encyclopedia Wikipedia indicate the replacement of traditional long-time assumption of knowledge spaces by time-critical up-dates of the present - which results in con-temporary time layers, as long as older and newer versions are not erased but stored. The Wayback Machine for obsolete web pages from the Internet (operated by archive.org) is a heroic manifestation of such options of techno-memory mobility.

Liberating reality from "time": *Eigenzeit* takes over

The classical definition of time (by Aristotle) is explicitely bound to the perception of movement (mobility). Speed has been calculated since antiquity; acceleration and dynamics become analyzable by the Leibnizean differential calculus. Here, time is still understood in its scientific sense as an external physical parameter. Today the traditional notion of vehicular transfer is being replaced by the mathematically calculated tunneling of the channel (Claude Shannon), short-cutting distance - rather teleportation than telecommunication. Nonlinear time is part of the mathematical geometrization of temporality, different from the one-directional "time arrow" provided by physical entropy. Mobile communication in the "digital" present is rather confronted with heterochronotopies (in allusion to Michail Bachtin's term "chronotope" and Michel Foucault's notion of "other spaces"). Networked locations which can be addressed with the speed of electricity replace the still energetically biased spatial notion of "mobile" transfer. Harold Innis once directed academic attention in analyzing cultural and imperial power to the media-induced "bias" of communication which is either space- or time-enhancing; thus spatial mobility is matched by chrono-mobility. This mobility within time has now transformed into chrono-logical mobility itself. Mobility has traditionally been understood as happening *within* the grid (or frame, or Cartesian coordinates) of time and space. But from a different, micro-temporal perspective, a variety of *Eigenzeit* figures appears - times endogenic to subsystems, to media as well as to organisms.

The experience of modernity has been an acceleration of delay or speed as explosions of temporal experience. But this experience is still conveniently framed by the parameter time (*t*) which is experienced phenomenologically (Husserl, Bergson) and related to media like phonograph and kinematograph. Being measured by clocks (Martin Heidegger's "vulgar time"), this is "mathematical" time (Henri Bergson). But in the age of active digital calculation, this mathemaical time itself becomes operative, resulting in a de-coupling of tempor(e)alities from the despotic signifier "time". This requires different terms to nominate these temporal kaleidoskope (requiring "chronopoetics"[441]). Jean Baudrillard identified the current *implosion* of history as discourse; Bernard Stiegler names it *ekstasis* of time.[442]

TECHNOLOGIES OF CULTURAL HERITAGE: "COLD" STORAGE, "TIMELESS" CODES

The exhibition *[Sound] Listening to the World* presents the century-old Berlin *Lautarchiv* and *Phonogrammarchiv* [443], as an impressive collection of phonographic recordings for linguistic and music-ethnographic research. While in 1999, the recordings of the *Phonogrammarchiv* have been included in the UNESCO inventory of immaterial cultural heritage, representatives of the native American Navajo tribe, question the legitimacy of such historic collections, and demand the silencing or even destruction of the ritual songs recorded by music ethnologist Georg Herzog between 1929-32. The Navajo claim that the ceremonical function of their recorded songs is not compatible with the concept of "cultural heritage" at all.

Viewed from a media archaeological point of view which looks at the medium message in this debate rather than at its ethical content, a direct link between the concept of cultural heritage and technological recording is apparently admitted here. If the focus is on the techno-logical rather than logo-centric conditions of such a debate, the primary driving force of the Berlin *Lautarchiv*, Erich Moritz von Hornbostel, comes into the discussion. In his essay on *Phonographische Methoden* for music-ethnological research (1930), explicitely insists on the production of galvanic negatives of original recordings on Edison cylinder, to turn such musical heritage which UNESCO classifies as "immaterial" into an enduring one.[444]

Cultural heritage increasingly needs to be addressed in technical terms indeed - even more, in its literal sense. Generations later, the Society of Applied Informatic in Berlin-Adlershof (GFaI) has developed a technique for the non-

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441 See W. E., Chronopoetics. The Temporal Being and Operativity of Technological Media, transl. by Anthony Enns, London / New York (Rowman & Littlefield) 2016

442 Bernard Stiegler, Denken bis an die Grenzen der Maschine, edited by Erich Hörl, Berlin / Zürich (diaphanes) 2009, 69

443 Humboldt-Box, Berlin, March to September 2018

444 "Die galvano-plastische Reproduktion der Originalphonogramme ist unerläßlich, wenn die Aufnahme in einem unvergänglichen Material aufbewahrt oder wenn sie vervielfältigt werden soll", as quoted in the *[Sound]* exhibition

invasive scanning of such negative sound recordings, combining high-sensitive mechanical sensors with optical scanning, subsequent digital sampling and finally algorithmic improvement of the signal-to-noise ratio of the derived sonic signals. All of the sudden, it is only the technological apparatus itself which grants access to such cultural heritage:

Fig.: Spubito-Tonspur-Riß (MEDIATHEK)

Tradition in technical terms: Transmission across space / storage over time

Cultural articulation, when communicated across spatial distance, may be exhausted after signal transmission and decoding by the receiver. When intended to be communicated into the future, though (with the channel of transmission becoming "suspended" or "frozen", that is: storage time), the signals requires material embodiment for endurance. Both modes, "transmission" and "storage", can be formulated as extreme formulations of one and the same theory cultural communication engineering.

So far, cultural heritage concepts have concentrated on redundant (secure) transmission. But in terms of communication theory, the degree of information increases with improbability and belatedness.[445] Tele-communication across spatial distance takes place in the more or less synchronous temporal mode (real-time), while the tradition of knowledge is remarkably asynchronous (postponed, "delayed transfer" in terms of Jack Goody) - the "postal letter" paradigm of humanistic knowledge exchange.

Cultural "heritage" is a metaphor borrowed from genetics. Jurij Lotman, though, defined cultural exactly as non-hereditary memory, achieved by neg-entropic agencies of ordered preservation: libraries, archives, museums. Only coded transmission is hereditary in the "genetic" sense by time-invariant symbols (be it alphabetic, be it the alphanumeric code). In that sense Alfred North Whitehead could characterize the European philosophical tradition in terms of the book machine: "[i]t consists of a series of footnotes to Plato."[446]
From that derives a split paradigm for the preservation of cultural heritage: Whereas coded knowledge can be transferred from one material carrier to another storage medium (like parchment and the printed book) without essential loss of information, technical signal recording is highly dependent on its technically specific medium idiosyncaries.

Agencies of cultural transmission across time

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445 Warren Weaver, Recent Contributions to the Mathematical Theory of Communication, in: Claude E. Shannon / same author, The Mathematical Theory of Communication, Urbana, Ill. (University of Illinois Press) [*1949] 1963, 1-28
446 Alfred North Whitehead's Process and Reality [*1929] Free Press edition 1979, p. 39

Conventional institutionalized "techniques" of cultural tradition (archives, libraries, museums) have escalated (or even disrupted) into autonomous machines, therefore: technologies of cultural heritage.

Different from "hot" historiographical imagination based upon texts, the mechanisation of the library itself as container of alphabet-based knowledge resulted in literal "cold storage", which is the title of a YouTube video produced by MetaLab, Harvard University on the infrastructure of its library, inspired by Alain Resnais' film on the National Library in Paris *Tout la Mémoire du Monde*.[447]

[The return of energy within information storage: material and energetic conditions for signal and data storage]

In terms of media ecology, there is significant energy costs for maintaining cultural heritage in memory institutions such as archives for unique records and libraries for textually coded knowledge on the one hand, and museum for materialities of culture.[448] At that point, the Norwegean National Library comes in, with its two bodies of memory: conventional books on the one side and technological records on the other - logical *versus* physical preservation.

Increasingly, any contemporary study of technologies of cultural tradition is confronted with the criterium of its ecological impact, the "anthropocenic" issue of hardware consumption and computational energy costs. The embodied energy of museum collections (as memory-accumulators), its "mnemic energy" (as applied by Aby Warburg for cultural transmission, derived from Richard Semon) turns technological; the infrastructure of memory itself becomes an "media ecological" issue in both McLuhan's and environmental studies sense. The focus on the material and energetic factors in museum heritage corresponds with the media-archaeological focus on hardware and and techno-logical infrastructures.

In the museum, the endurance of physical artifacts is incommensurable with its digital museology (in data centers) in terms of temperature, humidity, energy use and embodied energy. Once more, physical and/or informational "entropy" clash. Technicians at Mo i Rana take care of media memory in the Boltzmann-entropy sense, while the National Library in Oslo takes care of the informational memory in the Shannon-sense. Within computational culture (Google's or "virtual" stock market server farms) this divide between the material and informational aspects of computational power continues. This requires a grounding of analysis in its precise material and symbolical techno-logical condition: cables, tubes, heating systems, protocols, codes.[449]

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447 *Cold Storage* Teaser Trailer, by metaLAB(at)Harvard (2014), on the Harvard Depository in Southborough, Massachusetts, https://www.youtube.com/watch?v=7QuzrF5BYcI, accessed 21 March, 2014
448 As performed by Samir Bhomik (Media Lab Helsinki) in his dissertation at Aalto University School of Arts, Design and Architecture, Finland, 2016 *Deep Time of the Museum / The Materiality of Media Infrastructures*
449 See Alexander Galloway, Protocol, xxx

The traditional archive, library and museum has concentrated on the material storage medium. Once digitized, such an object becomes a "metaphor" indeed, subject to increasing periodic data "migration", transmission and processing.

For the post-industrial age, communication theory has declared that information is a new kind of epistemic essence, not energy nor matter (Wiener 1948). But high-frequency data processing, though apparently almost immaterial and hidden from obvious visibility, has resulted in more energy consumption and rare earth materialities than ever. Negentropic computing memory, embodied energy costs and the memory of material objects interlace in the maintainance of cultural heritage.

Here, heating and cooling system are inverted by the process of digitizing the museum objects, that is: translating them into a different form of existence, from matter and energy to information with a different "temperature" ratio. There is data entropy in using digitization of material heritage by scanning it into computers for further storage, processing and transmission, thereby turning the museum of artefacts into "cloud" collections for the representation and broadcasting of digital memory through networks, media installations and digitally-embedded museum spaces.[450] At the same time, with 3D-printing, a material object re-emerges as the very simulactum of heritage, connecting to the macro-temporal energy cycle of petrol by the very use of its plastic ingredients for printing (as accentuated in the Additivist manifesto).

Behind every act of digitization and digital representation lies a chain of material and energetic resources indeed, ranging from silicon chip manufacturing to voltage for high-frequency data processing.[451] The life-span of such non-human media infrastructures shrinks by the increasing speed of disruptive technological innovations; obsolete media technologies return to the earth as residue of digital culture, resulting in growing layers of toxic waste, returning the media "archaeological" metaphor into reality.[452] Digital cultural heritage is achieved for the price the environmental burden.

The timelessness of heritage-as-information vs. its material and energetic embodiment

Cultural heritage refers to *media* in two senses: genuine technical objects on the one hand, and pre-technological objects transformed ("sampled") into media records for preservation. Its core operation is the sampling-and-hold electronic module as micro media theatre of transsubstiating "analog" physical world signals into binary ("digital") information.

The notion of "heritage" privileges the receiver perspective; "tradition" is rather sender-centered. In terms of communication theory and engineering, the media-epistemic and -archaeological focus is on what happens inbetween, the

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450 See Samir Bhowmik, "Deep Time of the Museum: The Materiality of Media Infrastructures." Doctoral dissertation, Aalto University, Helsinki (Aalto Art Books) 2016, esp. chap. 5.2.3
451 See Bhowmik 2016
452 See Jussi Parikka, Media Geology, xxx, 2015

literate *medium* (channel) interval (both spatially and temporally): the analog transduction or discrete coding of signals for channel adaption.

Different from the field of texts or images, a more dramatical dis-continuity has been introduced to cultural heritage by technology in sound and speech which in pre-phonographic times had been inaccessible for technical preservation.

The tactical (media-archaeological) perspective deals with a precise analysis of the concrete scenarios which are critical within that scheme, such as signal transduction (analog) and coding (the sample-and-hold mechanism as core of A/D conversion), channel noise and storage media decay.

Flat temporality here replaces historicism and general concepts of "cultural memory": transitive analysis and the microscopic "close reading" of (and by) storage technologies, and its micro-epistemological critical reflection.

Analog-to-digital conversion is the "great transcription" (Rossaak) which, different e. g. from the manuscript-to-print transcription in early modernity or book rolls to parchment codex (the material condition of emperor Justinian's legal "code") in late antiquity, does not remain within the alphabetic code, but is in fact a spatio-temporal transcoding as well: digital sampling which depends on software (algorithms) to unfold again.

It is no more exclusively human collectives but machines which have become agencies of cultural heritage.

Material media entropy

Cultural transmission theory deals with two kinds of entropy. Against the necessities of storage temperatures (Mo i Rana), the concept of "informational" temperature has been developed. There have been *techniques* of cultural tradition so far; recent *technologies* are no simple escalation but a new epistemic quality in the transmission of cultural heritage.

Photographic negatives and prints, just as magnetic tapes charged with audio, video or binary signals, are subject to physical entropy - different from the informational entropy *within* digital photography.[453] In the Internet culture of *online* retrieval, digitally archived images, safely kept at a distance from immediate human contact, appear uncontaminated by the passage of time. When the analog photographic image is digitally sampled into coded symbols, it is iconic no more but a series of alphanumeric characters (as presented in the control room in the movie *The Matrix* (USA 1999).

Material media memory starts with its basic matter, such as electric condensers and the circuitry of technological configurations. Media-scientific (rather than hermeneutic) analysis of cultural artefacts is operated by non-

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453 See Wolfgang Hagen, Die Entropie der Fotografie. Skizzen zur einer Genealogie der digital-elektronischen Bildaufzeichnung, in: Herta Wolf (ed.), Paradigma Fotografie. Fotokritik am Ende des fotografischen Zeitalters, vol. 1, Frankfurt/M. (Suhrkamp) 2002, 195-235

human agents like measuring devices as active media archaeographs.[454] The preservation of material semantics and aesthetics[455] is an ever-growing problem for analog media art starting from old photographs, which have had a surprising endurance over 150 years, but increasingly turn yellow. Early cinematographic nitrate films with their chemical material tend to burn when stored somewhere too hot, or in colour films the colours fade away. So there is physical entropy, the tendency to particular disorder within the material. With the magnetic audio tape, one can listen to a 50 year old magnetic tape and still hear a lot - which is a positive surprise, but at the same time there are increasing dropouts. Only here "time" passes as physical intrusion.

Cooling down media memory: video testimony

While explorer Robert Scott and his men once have been immersed in the snow of the Antarctic, the phonographic negative films they produced have survived in cooled-down latency.

In contemporary media culture, in order to preserve digital memory for ages, it is advised to put devices like the USB stick in the refrigerator. Kryonics refers to the inverse Arrhenius equation: the speed of chemical reactions within the very materiality of electronic devices decreases with temperature.

There is "temperature" even in traumatic media memory. The idea to audio-visually record the testimonies of Holocaust survivors, initiated in 1979 by Dori Laub, took shape as the "Holocaust Survivors Film Project. "Despite the name, filming was conducted from the start in videotape"[456] with the original recording format being three-quarter-inch U-Matic videocassettes. "Due to deterioration of the magnetic tape, the original videocassettes are currently stored in a temperature-controlled room in the Yale archives. The video testimonies currently available for viewing at Yale are all VHS copies of the originals."[457]

A temperature-controlled room in video archives can only slow down, but not arrest the entropy of the magnetic tape. The vulnerability of material signal carriers to physical entropy is counter-acted neg-entropically by digitization - "[...] a development that reasserts the tension between storage and dissemination at the base of this archive."[458] On the techno-material, media-

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454 See Josef Riederer / Alheidis von Rohr (ed.), Kunst unter Mikroskop und Sonde. Naturwissenschaftliche Untersuchungen an kulturhistorischen Objekten, Handbuch zur Ausstellung der Staatlichen Museen Preußischer Kulturbesitz (Berlin 1973)
455 See W. E., Zeit, die an Medienmaterie haftet. Erkenntnismöglichkeiten technoarchäologischer Hardware, in: Irene Schubiger (ed.), Schweizer Videokunst der 1970er und 1980er Jahre. Eine Rekonstruktion, Zürich (Ringier Verlag) 2009, 188-194
456 Amit Pinchevski, in: The Audiovisual Unconsciousness: Media and Trauma in the Video Archive for Holocaust Testimonies, in: Critical Inquiry, vol. 39, no. 1 (Autumn 2012), 142-166 (145)
457 Pinchevski 2012: 145, note 7
458 See Amit Pinchevski, The Audiovisual Unconscious. Media and Trauma in the Video Archive for Holocaust Testimonies, in: Critical Inquiry, vol. 39, no. 1

archaeological level, the entropy of *analog* video testimonies still shares the sense of history: slow degradation, wasting away. This is familiar to the human experience of time as passing, the one-directional time arrow. But digital sampling freezes such a video recording in its actual state, suspending it from "history" as further transformation. There is a remarkable difference between analog video deterioration and digital pixel artifacts (or glitches in the sonic sphere) - a different kind of testimony, to time itself.

For signal storage, so-called "archival tapes" (magnetophonic records) in broadcast archives (radio, television) need to be gently heated up to decoalesce in order to play them again for copying, digitizing and migration

Instead of focusing on the ecological costs of cultural heritage technologies, radical media archaeology, being close to techno-mathematics, concentrates on the other side of such entropy.

The material vulnerability of material signal carriers to physical entropy is being counter-acted ("neg-entropically", in Norbert Wiener's sense) by converting it into digital information. All of the sudden, passive storage turns into knowledge in latency. Once being digitized, the electronic image is open to algorithmic search options like similarity-based image retrieval. The traditional architecture of the archive is based on classificating records by external inventories / metadata. Analyzing a digital image from *within* allows for detecting order in fluctuation, that is: dynamic, which is an "archive" no more, but algorithmically ruled processuality. After scanning an image, entropy defines "how easy it is to predict the unknown data values given the values we already know. If an image consists of a few monochrome areas, its entropy will be low"[459] The physical laws of thermodynamics habe been transformed into a measure of information in the mathematical calculus of information engineering (Shannon) and therefore returns within computation and data compression itself.

"Tradition" of cultural knowledge in terms of communication engineering

While phonographic recording captures the temporally unique acoustic signal for time-shiftable identical *reproduction*, the alternative is its techno-mathematical Fourier analysis as transformation of the wave form into its numerical frequencies. Coded transmission not only allows for almost lossless reproduction (case photography, in Walter Benjamin's sense) which is subject to quality loss, but for identical *regeneration*. Discretely coded (not modulated) signals even imply their mapping onto another (future) "alphabet", just like typography (the mechanically printed book), different from the graphic idiosyncrasies of the manuscript, invites for identical reproduction already as its very technical *raison d'être* (*arché*). From that derives an immediacy of communication between sender and receiver (author / reader) which short-

(Autumn 2012), 142-166 (145, note 7)
459 Lev Manovich, How to Compare One Million Images?, in: Understanding Digital Humanities, hg. v. David M. Berry. Basingstoke: Palgrave Macmillan 2012, 249-278 (266)

circuits historical distance in favor of time-delayed "real presence"[460] of its semantic issue (case Platon's literal *Dialogues*).

Different from analog communication where a non-cultural physical signal (such as high fequency electro-magnetic waves for radio broadcasting) is *modulated* by cultural articulation like speech or sound, digital communication, though still depending on embodiment in physical signals, achieves a mathematical abstraction from noisy material carriers by *coding*. The signal is not simply transduced but informatized, like a sequence of electric impulses can be mapped to the ternary Morse code (which itself is mapped onto the alphabet). Archaeological heritage is signals from the past which requires real numbers to mathematically describe their qualities, while symbolically coded heritage allows for mapping it to integer numbers which makes it (after Leibniz' dyadic system and Boole's symbolic algebra and Shannon's mapping this to switching circuits) accessible to binary computing. Such symbols still require residual embodiment in physical signals, but the variety of such materiality does not affect the invariance of the code - be it mechanic, optic, acoustic, magnetic or electric.[461]

The media-archaeological dispositive for (almost) lossless reproduction of information by identical symbols has been the Gutenberg printing technology (as opposed to handwritten copies of manuscripts) with its negative types to re-produce letters positively in identical numbers - a form of reproduction later reinvented by the photographic negative, the Talbot Kalotype (as different from the unique Daguerre positive), which led Walter Benjamin to remark that reproduction technology both disconnected and liberated the reproduced object from its ritual contect, by replacing the unique event in space and time (the condition for its "auratic" character) by its expositional value. Tradition is thus replaced by mechanisms of transmission, storage and processing.[462]

The monopoly of telecommunication across space and time, once held by state-owned mailing, archival and telephone systems, according to an argument by Bernhard Siegert, ended with the digitalization, where transmission itself (in its traditional sense) runs out, becoming a mere function of mathematised (rather than materially transmissional) signal processing (realtime, compressing etc.).[463]

"How, by what channels and by what techniques, were the spiritual *arcana ecclesiae* transferred to the state so as to produce the new secular arcana

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460 Ernst Robert Curtius, Europäische Literatur und Lateinisches Mittelalter, Bern 1948, 24
461 "Alle diese Signale können im Prinzip zur Darstellung ein und desselben Signalcodes eingesetzt werden." Franz Pichler, Codes: Mathematische Objekte zur Übermittlung von Nachrichten, in: Peter Weibel (ed.), Open Codes. Leben in digitalen Welten, brochure to exhibition at Zentrum für Kunst und Medien, Karlsruhe (zkm) 2017, 39-41 (39)
462 Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [originally published in its French translation 1936], Frankfurt/M. (Suhrkamp) 1963, 13
463 Siegert 2003: 285

imperii of absolutism?", historian Ernst H. Kantorowicz once asked.[464] There has been a long cultural tradition of techniques to preserve cultural knowledge across generations. The discursive perspective for memory instutions has been strategic, that is: in long, that is: "historic", almost eternal time spans. In times of media culture, this horizon is replaced by short-term intervals, both due to a change in the phenomenology of cultural time and due to increased speed of technological innovations. Not only that heritage agencies have become more technological themselves, but technological solutions for preservation do not allow for long-time strategies any more. They ask for tactical skills. Memory agencies are not primarily about cultural memory any as such but about flexible adaption of cultural records to technological changes. Emphatic concepts like heritage are replaced by what in computation is called "buffer" or even "cache" memory.

The notion of "half time", well known from calculating the decrease of radiation in nuclear waste depositories, exists for the discourse of knowledge as well. There is nowledge measurement in the alphabetic regime as well. Bibliometry calculates the time in which a publication is heavily read, borrowed from libraries and quoted, resulting in the citation index which once induced the origin of the "PageRank algorithm" for the search engine Google.[465]

Only non-human-addressed texts, sounds and images, can be still retrieved when the defining cultural semantic or iconologic context has already been lost. Some proposals for long-time security and visibility of nuclear deposit sites still count with human recognition in the far future. Among the strategies to symbolically mark nuclear waste depositories such as in Carlsbad, New Mexico, where the radio-active half time is calculated for 10 000 years, one of the options is a *Gestalt* diagram ("Mister Yuk"), in fact a human face which by geological move of the North pole will change its expression from angry to friendly within such 10 000 years. This "slow motion" communication examplifies the option of (auto-)"correlation": invariant self-similarity of signals over time.[466]

The changes of a successful decoding of textual messages in the far future deepends on transmitting its code as well. Ventris deciphered Mycenean "Linear B" writing from ancient Greece on the basis of his training in Second World War time decipherment of coded messages[467] - the very context which generated the mathematical theory of communication (Shannon) as well.

[Within such coded messages, proper names are "rigid" denominators in Kripke's sense; they do not change with context. Alan Turing managed to crack, in Bletchley Park's decipherment huts, the German military code (codes by the Enigma machine) by concentrating on proper names in the sequence of encoded letters, just like the decifferment of "Linear B" by Ventris / Chadwick

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464 Mysteries of State. An Absolutist Concept And Its Late Mediaeval Origins, in: Hardvard Theological Review vol. 47 (1955), 65
465 See Larry Page / Sergej Brin, xxx
466 See Gregory Benford, Deep Time. How Humanity Communicates Across Millennia, xxx (Avon) 1999
467 See Michael Ventris / John Chadwick, Documents in Mycenean Greek, Cambridge 1956

and of the Rosetta Stone by Champillon (the pharao's name, marked by graphic accentuation). When the deciphering becomes time-critial (which is not true for cultural semiotics, paleography or nuclear deposits), highly technical computing becomes vital as real-time mathematics.]

Semiotics, when understood in terms of communication engineering rather than as cultural studies, is a branch of communication dealing with the study of "the formulation and endoding of messages by sources, the transmission of these messages through channels, the decoding and interpretaionof these messages by destinations, and their signification."[468] Umberto Eco's introduction into semiotics, through, clearly separates sign from signal.

The mathematical theory of communication has been criticized from within the humanities for not being concerned with the "semantics" of the transmitted signals; that is why "noise" here is not just a distortion but as well a possible source of information (just like in secret coding).

Towards a mathematical theory of archival memory communication

Instead of concepts in historical discourse, options of cultural heritage transmission might be calculated in terms of probabilities, based on the entropy theorem from communication engineering. As opposed to analog wave forms, discrete impulses, against distortions or noise to the signal, can almost ideally be relatively easily detected, filtered and regenerated in the transmission channel[469] after reception (and in reverse coded respective the channel in the moment of transmitting) by application of the *repeater-regenerator*, a device allowing for quasi-invariant signal transmission. Binary information here beats the traditional parameters of "historiographical" tradition. Binary (on-off) PCM allows for maintaining a high quality signal in spite of noise and interference, as long as it is just possible to recognize the presence of each pulse across a spatial or temporal distance. The noise in the transmission channel is replaced by noise on the signifying level, the critical moment of transduction. In PCM systems, the signal-to-noise ratio is set by the quantizing noise of analog-to-digital sampling.[470]

This is the ratio of symbolically coded heritage in terms of communication theory: "Assume the received signal E to be a function of the transmitted signal S and a second variable, the noise N. <...> The noise is considered to be a chance variable just as the message <...>. In general it may be represented by a suitable stochastic process"[471]; probabilities for the preservation of cultural artefacts can thus be calculated in mathematical terms: E = f(S, N), with adding the temporal dimension to the communication channel: E = f(S, N, t).

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468 As defined in Sebeok 1985: 451
469 Roch 2009: 102
470 See Claude E. Shannon / John R. Pierce / B. M. Oliver, The Philosophy of PCM [*1948], in: N. Sloane / A. Wyner (ed.), Claude Elwood Shannon. Collected Papers, Piscataway (IEEE) 1993, 151-159 (155)
471 Claude E. Shannon, The Mathematical Theory of Communication [1948], in: idem / Warren Weaver 1963: 29-125 (65)

Right at the beginning of his book, Norbert Wiener's biographer Masani formulated the problem of biographies in terms of such a *signal-to-noise ratio*: "The basic proposition of cybernetics that signal = message + noise, and that the message, and not the noise, is the sensible term in communication, is applicable in all sorts of contexts <...>. Wiener is the signal, and for us the Wiener-message, and not the Wiener-noise, must be of significance."[472]

Instead of a rigid dichotomy, there is rather a delicate transition between immediate signal "transmission" and delay by "storage", as becomes apparent in magnetic voice recording at the very moment of its technical invention by Oberlin Smith in 1888: "Imagine that speech could be transmitted over a telephone line at a very slow 'rate of travel', so that at a particular point in time the entire message would be somewhere in the wire between speaker and listener"[473] - literally "in the medium" (Shannon's definition of the transmission channel). Acoustic delay lines have been in use for random access memory in early digital computers.

Coding cultural memory: Re-generative instead of material tradition

Conceived in terms of cultural history, "[t]radition is nothing if not diachronic."[474] Really? The meaning of "cultural heritage" shifts its focus from its previous emphatic macro-temporal ("historical") notion to the analysis of the nonlinear time-based and time-basing micro-mechanisms of transmission. While tradition has been associated with long-time memories across deep historical time so far, this emphatic horizon now shrinks to a mere extension of the present (as its re- and protentive short-term "working memory") - a dramatic shift of the temporal prefix in the age of algorithmic, that is: generative (instead of inherited) memory. Algorithmic re-production is the post-scriptum to Walter Benjamin's interpretation of post-traditional perception of works of art - a kind of oral (in the sense of: dynamic, variable) memory returns.

In the age of algorithmically driven data processing, re-generative (instead of inherited) memory takes place, a techno-*poiesis* of tradition (as known from the definition of rhythmicized oral poetry[475], relegating the past to the present not by notational or phonographic signal recording but by re-enactment.

In communication engineering, the binary coded signal has been preferred against the analog wave form which is vulnerable to all kind of noise in transmission - just as alphabetic writing against the continuous voice in oral poetry. Coded pulse trains allow a significantly more secure form of

472 P. R. Masani, Norbert Wiener 1894-1964, Basel / Boston / Berlin (Birkhäuser) 1990, 19
473 Friedrich Karl Engel, A Hundred Years of Magnetic Sound Recording, in: Journal of the Audio Engineering Society, Vol. 36, No. 3 (March 1986), 170-178 (171)
474 John Miles Foley, Traditional Oral Epic. The Odyssey, Beowulf, and the Serbo-Croatian Return Song, Berkeley / Los Angeles / Oxford (University of California Press) 1990, 3
475 Foley 1990: 200

transmitting and storing the signal against unintended noise and mathematically calculated efficiancy.

Memory records from media culture consist of two bodies: the material (subject to physical deterioriation / Boltzman entropy) and the logical (almost invariant regarding the "historic" time arrow, Shannon-entropy like informational space). The symbolical notation of time and its physical reality are incommensurable.[476] But even in logical space, since its symbols have to be embodied in some kind of matter (be it paper and ink), there is no zero-entropy. Symbolical codes have to be materialized as analog signals in physical matter like a phonographic groove; thereby they are subject to material corruption "with time", that is: Boltzmann-entropically.

A sequence of dots and dashes in Morse telegraphy is not simply a symbolic expresssion like articulated speech or alphabetic writing, but the symbolic is embedded in a physical *time* signal, thereby unfolding in a world of its own. During transmission (the Delta-*t* interval of the *medium* channel) the intended message is suspended from the symbolic and temporariliy assumes a non-cultural existence.

Against physical deteriorization with time, the symbolic code is neg-entropic. In antiquity, Ptolemy´s atlas of the world was meant to be handed down to posterity in what Mario Carpo calls a "digital format". After listing the locations, for each place he indicates the geographic coordinates and then advises not to copy the actual maps but to regenerate it on the basis of the numerical data exclusively. So what is transmitted is not the picture but an alphanumeric code. But once encrypted, the message depends on the knowledge and sharing of software to decipher and recreate the image itself, resulting in an a-historic form of tradition; a re-generative memory. In that way, the alphanumeric code is more enduring than marble, parchment or architecture. "Geometry is still geometry, regardless of the machines that process it - compasses or computers."[477]

In antiquity, Ptolemy's *Geography* developed a model for lossless tradition by means of coding the map (that is: informatisation). Ptolemy faced the risk of errors in manual copying of charts by radical digitization.

For textual transmission since Homeric times in antiquity, the alphabet as a "technology" of coding language[478] made cultural transmission of word-based knowledge. In the Renaissance, Leon Battista Alberti in his treatise *De statua* proposed a procedure for the lossless transmission of three-dimensional objects by digitalisation. When a body is subdivided into a network of discrete points; the position in space of each one can be precisely indicated by a system of

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476 See Michel de Certeau, Writing vs. Time: History and Anthropology in the works of Lafitau, in: Rethinking History. Time, Myth, and Writing, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980), 37-64
477 Mario Carpo, Building with Geometry, Drawing with Numbers, in: Andrew Goodhouse (ed.), When Is the Digital in Architecture?, Montreal / Berlin (Canadian Center for Architecture / Sternberg Press) 2017, 33-44 (43)
478 Walter Ong, Orality and Literacy. The Technologizing of the Word, London 1982

coordinates, allowing for the material body to be symbolically copied and reproduced.[479] This invulnerability agains noise in hand-drawn copying is the ratio of Shannon's mathematical theory of channel-coding for transmission of messages - be it at a spatial or temporal distance.

"The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point."[480]

Technologies of communication transmission (across space) and storage (across time) converge; "delayed transfer" is a term once coined by Jack Goody for symbolically coded archival tradition. A coded message may be deciphered at any moment in later times (as long as the reader shares the knowledge of the originary alphabet).

[Oscillating between message and noise: Reading *Lapis Satricanus*]

Not only that the present increasingly communicates its cultural heritage by digital text, sound or image files; the past already has been symbolically, even digitally registered as alphabetic code.

A scene where symbolical writing and material archaeology meet is on / in ancient inscriptions, such as the *Lapis Satricanus* from late 6th or early 5th century B. C., discovered 1977 by the archaeologists of the Dutch Institute of Rome during their re-excavation of the temple of Mater Matuta in Le Ferriere (Latio), the ancient Satricum.

Fig.: http://www.telemaco.unibo.it/rombo/iscriz/satricum.htm

The textual inscription, like flat files of data strings in computing today, does not itself separate words. The epigraphical reading presents the text like this:

[........]EISTETERAIPOPLIOSIOVALESIOSIO
         SUODALESMAMARTEI

The reproduction of this early Latin votive inscription of just two lines in print tends to reduce it to coded transmission. But the challenge of any symbolical when embedded in matter (the very nature of technological heritage) is that the real takes revenge. The inscription itself is already deficient at the beginning: the first letters are missing, no *arché-logos*. This initial lack which remains to be supplemented keeps the discussion of hypotheses going on.[481] A revision of the ealiest photographic documentation of the stone *in situ* by D. J.

[479] On Alberti´s method of digital sampling, especially his *Carta urbis Romae* for lossless "digital" transmission of map of Rome to posterity, see Mario Carpo, "Descriptio urbis Romae". Ekphrasis geografica e cultura visuale all´alba della rivoluzione tipografica, in: Albertiana, Florenz (Olschki) 1, 1 (1998), 111-132
[480] Shannon / Weaver, The Mathematical Theory of Communication (1949), 31. Siehe auch Bernhard Vief, Die Inflation der Igel. Versuch über die Medien, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (Hg.), McLuhan neu lesen. Kritische Analysen zu Medien und Kultur im 21. Jahrhundert, Berlin (transcript) 2008, 213-232

Waarsenburg in 1994 - a kind of secondary dig in the archives of archaeology itself - revealed that the literally "i"nitial lacuna can, at least partly, be completed by the letter "I", while another apparent fragment of a letter on the photography, blown up media-archaeologically by computer analysis, turned out to be a blade of grass.[482] What is the message, or what is missing: truncated first letter/s or noise (a scratch in the stone)?

A photograph of the primary situation of this inscription when just being excavated *in situ* today is the only recording of its state before the cleaning of the stone from earth and its removal into an epigraphic museum.

The completion of the first word(s) would require either a reverse lexicographic statistical processing of letter sequences, or an analysis of Markov chains as proposed in the mathematical theory of communication (Shannon and Weaver 1963); our certainty depends on statistical probability.

As expressed by Claude Shannon in his essay on prediction and entropy: "The errors, as would be expected, occur most frequently at the beginning of words and syllables where the line of thought has more possibility of branching out."[483]

Only a proper name (*poplios* = Publius?) makes it secure to discriminate a verbal entity; names turn out to be the ultimate rigid denominator (Saul Kripke). The problem of reading the inscription is with how to group and de/compose the letter series in front of this name: the analysis of *ieisteterai* and the problematic integration of the 4-6 letters missing already at the left corner of the inscription, turning this epigraphical case into an allegory of readability of the past (which is by definition absent and deficient). Only a statistical *ars combinatoria* (somewhat at the origins of computing) can offer different readings by sequencing these letter-data:

A) [4-6]*ie iste terai*
B) [4-6]*iei stet erai*
C) [4-6]*iei steterai*
D) [4-6]*ieis tet erai*
E) [4-6]*ieis teterai*
F) [4-6]*ieist et erai* [484]

Image processing routines may be applied to enhance shallow inscriptions and

481 See Bernhard Siegert's discussion of the print representation of corrupt letters in the ancient Roman inscription *Monumentum Ancyranum* in Andreas Schott's edition (Antwerpen 1579), where *lacunae* are expressed by subsequent dots: entry "Kulturtechnik", in: Harun Maye / Leander Scholz (eds.), Einführung in die Kulturwissenschaft, Paderborn 2011, 95-118 (110 f.)
482 Versnel 1997: 180
483 C. E. Shannon, Prediction and Entropy of Printed English, in: The Bell System Technical Journal, Bd. 30, Heft 1 (Jan. 1951), 50-64 (54f)
484 C. De Simone, L'aspetto linguistico, in: C. M. Stibbe, G. Colonna, C. de Simone and H. S. Versnel, with an introduction by M. Pallottino, Lapis Satricanus. Archaeological, Epigraphical, Linguistic & Historical Aspects of the New Inscription from Satricum, 's-Gravenhage 1980, 71

thereby support their deciphering; in calculated enlargment of this close-up by digital filtering (in PhotoShop), digital media themselves act as active "archaeologists" of this past; techno-mathematical signal correlation of (missing-to-existing) letters.

The media archaeological focus on the decisive technological scenarios of tradition is rather microscopical than in terms of historical macro-contexts; in its time lense, temporal distance is compressed to immediacy in the symbolic regime.

The metaphor of the micro- or telescope turns the analysis of heritage into a laboratory practice which itself depends on technologies of detection[485] - just like Walter Benjamin defined the "optical unconscious" which is revealed only by the photographic lense.

Mutilated cuneiform inscriptions from ancient Mesopotamia, e. g., may be restored by holographic signal processing, identifyng visual "spikes" in correlation analysis:

Fig. 5, in: Günther Wernicke, Holographische Zeichenerkennung an Keilschrifttafeln, in: Humboldt-Spektrum 4/1995, 22-27

"Emulation". The challenge of operative software heritage

With classical archaeology (classics) and *Kulturwissenschaften*, media archaeology shares the interest for material culture. What differentiates technological objects from archaeologically excavated cultural artefacts is their being (technically as well as logically) coupled and - contrary to a museal assembly - capacity of acting - under currency - by themselves. This escalation can not be articulated by immobile exhibition or frozen storage only[486] but requires re-enactment.

Re-enactment requires "a transhistorical *operative practice*"[487] which correlates with Heidegger's reading of ancient Greek techné: "a 'revealing' that not only 'brings forth' but also *makes present*" <324>. The material and logical conditions under which stored signals from the past can be "re-presenced" are central to media archaeology indeed.[488]

Within electronic computing, the traditionally separated categories of durable materiality *versus* immaterial reproducible code collapses.

In order to conncect to the physical world, there is the necessity of material implementation of all logical systems to become dramatically active. Just like mental processes depend on their implementation in bio-cybernetical hardware

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485 See Georges Canguilhem, Wissenschaftsgeschichte und Epistemologie, Frankfurt/M. (Suhrkamp) 1979, 25
486 See Steven Lubar / W. David Kingery (eds.), History from Things. Essays on Material Culture, Washington / London (Smithsonian Institution Press) 1993
487 Sobchack 2011: 324
488 Sobchack 2011: 323

(neuronal synapses)[489], techno-symbolical analysis (*Schaltalgebra*) itself can operate only when being implemented into swichting circuits (such as electro-magnetic relays).[490] There is a crucial difference between the mathematical paper model of the Turing-Machine of 1936 and the really implemented machinery called "computer" today which brings speed as a time-critical parameter into the algorithmic event.

Digital culture itself has generated a new epistemology for its own heritage: the concept of emulation. Different from a soft concept of emulation which only cares for the recreation of the phenomena and appearance of the machine-to-human interaction, emulation in its radical sense actually re-enacts the function of an obsolte computer (and its temporal behaviour in the strong sense of simulation) *within* a contemporary one. It ontologically actually *is* in the state of the previous one (resulting from the concept of the Universal Turingmachine which is able to emulate any other machines once coded). Remains the challenge of migrating and emulating to future systems the emulator software itself.[491]

[When a present computer emulates a previous computer game designed, e. g., for a Commodore 64, it is in both a historical and a trans-historical state. It *is* (according to the definition of the Universal Turing Machine) in the C64 configuration, while at the same time, in the background the contemporary operating system is running. The timing of the present system speeds the emulation up, so that the characteristic C64 time behaviour as once coded in BASIC language has artificially to be simulated. With the temporal dimension functional emulation (the matahistorical realm of techno-mathematical logic) becomes "hight fidelity" in terms of micro-temporal behaviour. Today's "retro computing" resembles what is known as *reverse engineering*.[492] It liberates the primary artefact, the C64 computer, from its overwhelming historisation and musealisation, and rather identifies the time-tunneling immediacy of its operational being.]

The department for *Computing and Control* at the National Museum of Science and Industry in London nowadays faces the challenge of the preservation of software as museum object.[493] Software represents a new kind of cultural artefact indeed. Essentially, it is not a material object any more, rather an executable file which unfolds only when being processed (a truly processual time-object). While the computer as hardware can be traditionally displayed as an immobile museum object, its time- and "bit-critical" processes are never in *stasis*.

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489 See Geoffrey Jefferson, The Mind of Mechanical Man, in: British Medical Journal, June 25, 1949, 1106-1110
490 See Claude Shannon's master thesis: A symbolic analysis of switching relays, in: xxx
491 See Jens-Martin Loebel, Lost in Translation. Leistungsfähigkeit, Einsatz und Grenzen bei der Langzeitbewahrung digitaler multimedialer Objekte am Beispiel von Computerspielen, Glückstadt (VWH Verlag Werner Hülsbusch) 2014
492 See xxx, Reversing, xxx (Wiley) xxx
493 Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing Vol. 4 No 3 (1992), 206-210

When techno-archivally "proteced mode" knowledge of both hard- and software is replaced by "open access", this will result in a more probable ensurance for tradition of media culture. Software repositories like GitHub keep the sources of digital culture transparent. May this kernel of contemporary cultural heritage be migrated into the future.[494]

When the concept of emulation, in its media archaeological sense, encompasses the re-enactment of hardware as well, this becomes critical, e. g. for soundchips in early home computers like the legendary SID 6581 soundchip for the Commodore 64 which has been a hybrid of analog synthesizer components and digital circuitry for addressing them. Alternative to simply recording sound samples as future "historic quotes" of a SID soundchip, an emulator aims at re-creating its sonic effects which is critical since the hear detects the delicate difference between a simulated and an authentic analog sound.[495] Referring to Kenneth Thibodeau's criteria, every digital artefact is a trinity of physical, logical and conceptual object.[496] "[T]here is a spectrum of options for digital preservation ranging from an accent on preserving the technolgy [...] to preserving the things produced with the technology [...]" - while admitting that "for things, such as computer games, that are essentially embodiments of the technology should fall closer to the technology end of the spectrum"[497], by maintaining hard- and / or software in operation by emulation. Thibodeau's preferred priority, data format conversion, "abondons the original hardware and software" - disrespecting technology itself as authentic cultural record - "and overcomes obsolescence by reformatting data files to newer formats that can be retrieved and used with current software" <105>. "As technologies change over time, the presistent object form can ramin stable. Te only thin that needs to be changed is the translator. [...] In a persistent archives <sic>", different from Foucault's neographism of *l'archive*, "the collections are not materialized as such", aiming "at independenc eof technological infrastructure" <109>.Thibodeau's perspective is the archivist which explicitely privileges maintaining the legal integrity and *documentary* authenticity of the record provenance form against the priority in the maintenance of its original technological infrastructure, media archaeology considers the *monumental* essence of such technologies a value worth of preservation as cultural heritage in itself - since all technology, different from merely phyiscal natural objects, is an accumulation and condensation of "hard-wired" cultural knowledge itself. In the case of technically generated records, their familiar "historical context" is not social any more, but becomes autonomous as its media-archaeological context: electronic circuitry in terms of hardware, operating systems in terms of software.

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494 See Friedrich Kittler, Museums at the Digital Frontier, in: Thomas Keenan (ed.), Limits of the Museum, Barcelona (Fondacion Tapies) 199x, xxx

495 See Claus Pias, Medienphilologie und ihre Grenzen, in: Friedrich Balke / Rupert Gaderer (eds.), Medienphilologie. Konturen eines Paradimas, Göttingen (Wallstein) 2017, 364-385 (378 f.)

496 Kenneth Thibodeau, Overview of Technological Approaches to Digital Preservation and Challenges in Coming Years; http://www.clir/pubs/reports/pub107/thibodeau.html (accessed May 2017)

497 Kenneth Thibodeau, Digital Preservation Techniques: Evaluating the Options, in: Archivi e Computer, Bd. 11, Heft 2 (2001), 101-109 (104)

Different from previous cultural techniques of maintaining cultural heritage, the epoque of computational media has generated a "digitally born" concept unknown in previous cultural epistemology: "emulation". Media theory both enhances and delimits its range. The logical object (including the operating system of an obsolete computer) may be preserved well by emulating such software incapsulated in another software, but the early Cathode Ray Tube monitor for archaic computer game display had a different material semantics than the LED screen with its pixelised matrix. The temptations of "cloud computing", metaphorically dissimulating the hardware *a priori* of any computing, already results in strategies where even hardware disappears into the cloud: "To save bygone software, files, and more, researchers are working to emulate decades-old technology in the cloud", Jessica Leigh Hester reports[498], quoting Seth Anderson, the Yale University library's software preservation manager: "You're removing the physical element of it."

The answer to preserving hardware beyond its material existence is its physical modelling, just like Digital Signal Processing can emulate the physical world by virtual (informational) means. But this requires, beyond the "textual" archive of source codes, and beyond photographic or video recording, a symbolic notation of such hardware as well, such as circuit diagrams. By sampling analog signal processing to digital data, and by physical modelling, digital media culture, replacing former cultural techniques or even technologies of tradition by the *techno-logics* of computational heritage, has generated the tools for overcoming its own limitations - at least in principle, *en arché*. The media archaeology of the digital age has a concept for its own "historicity" already: *futurum exactum*.

HALF-LIVES OF KNOWLEDGE. A Media-Archaeological Point of View

In the discussion of how long knowledge can be expected to last, and in what form, the human factor is not longer exclusively determinant. Regarding the challenges and chances of maintaining knowledge across emphatic temporal distance, and in respect to the options of reconstructing lost or damaged knowledge, an "archaeological" perspective (in its various meanings ranging from the academic discipline up to Foucault's *Archéologie de Savoir* and even media-archaeology) is useful which focuses on the non-human agencies of knowledge traditions. Media theory here is helpful since it addresses both the philosophical (epistemological) and the engineering (techno-mathematical) questions involved. The present focus is on nuclear energy both as medium and as subject of knowledge reflection, with a special accent on the delicate relation between technology and time.

For the analysis of the techno-logics of knowledge tradition, a focus on both the material (technical) forms which are subject to physical entropy and on the immaterial (logical), almost time-invariant codes of transmission is required:

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498 In her article "The Quest for a Universal Translator for Old, Obsolete Computer Files" from March 8, 2018, website ATLAS OBSCURA, https://www.atlasobscura.com/articles/how-to-open-old-computer-files, accessed March 14, 2018

the physical *versus* the symbolical mode, material embodiment ("markers") *versus* logical implementations (archives). In this context "symbolic" does not refer to symbolism in its iconological sense of metaphorical meaning (such as the much discussed "markers" on nuclear waste sites[499]), but to discrete characters in coding information (ranging hitherto from alphabetic letters and Arabic numbers up to the binary code of Zeros and Ones embodied as Low and High voltage levels in electronic computing). The current shift from material memory as cultural premise to techno-mathematics as the dominant form of cultural communication corresponds with a different kind of tempor(e)ality: cultural memory once intended for eternity transforms into an on-going practice, economy and aesthetics of short-term intermediary storage: repeated data migration, "the enduring ephemeral"[500].

In every act of cultural transmission, there is a symbolical (code) level on the one hand which is tentatively time-invariant, and an entropical, temporally decaying physical reality on the other, as expressed in the allegory of history painted by Anton Raphael Mengs on the ceiling of the room which links the Vatican museum (material objects) to the Vatican library (the regime of symbolic writing).

Cultural analysis in the media-archaeological way

This analysis is both about the material forms of cultural tradition which are subject to physical entropy and the immaterial, almost time-invariant codes of transmission: the physical vs. the symbolical mode, material embodiment ("markers") vs. logical implementations (archives). The shift from archaeological materialities as cultural premise to techno-mathematics as the new form of enculturation corresponds with a different kind of tempor(e)ality: cultural memory once intended for eternity transforms into a perpetual practice of short-term intermediary storage: repeated data migration, "the enduring ephemeral"[501].

"Writing vs. Time": Lossless tradition in the symbolic code?

In every act of cultural transmission, there is a symbolical (code) level on the one hand which is time-invariant, and an entropical, temporally decaying ("historical") physical reality on the other. An illustration for tradition is Anton

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499 See the OECD Radioactive Waste Management publication *More than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Mangement* (2010)

500 See Wendy Chun, The Enduring Ephemeral, or The Future Is a Memory, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 184-203

501 See `Wendy Chun, The Enduring Ephemeral, or The Future Is a Memory, in: Erkki Huhtamo / Jussi Parikka (Hg.), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 184-203`

Raphael Mengs' *Allegory of History*, painted by on the ceiling of the room which links the Vatican museum (material heritage) to the Vatican library (the regime of symbolic signs).

There is another 18th century allegory of the mechanisms of cultural transmission, the frontispiece of Lafitau's publication *Moeurs des sauvages Ameriquains* (1724). This image confronts archaeologically silent, but enduring material artefacts with the discursive, but transient murmur of historiography. The viewer is confronted with

<...> the encounter of writing and time in a closed space littered with "vestiges" coming from both Classical Antiquity and the New World. One holds the pen, the other the scythe, <...> which approach each other without ever touching, asymptotically. History deals with relics which can be seen, and seeks to supply explanations; ancient *things* which have become mute throught the degradation owing to time may to some extent become clearer <...>.[502]

Michel de Certeau enhanced this allegory by drawing the configuration of Chronos and Clio abstracted to a diagram where the supposed prologued lines of the curved scythe and the linear pen become vectors. Diagrams do not depend on iconological representation while at the same time asking to be enacted by reasoning.

Directly deciphered in terms of mathematics, the pen-line (as x-axis) becomes the asymptote of the scythe as hyperbel (on the y-axis). There is no point where the function touches or traverses the x axis itself: no convergence between material and symbolic phenomena of time.

In Lafitau's front cover illustration, the allegorical figure of Chronos is endowed with a weapon (the scythe) indicating devastation with time - in fact „noise" which happens in the temporal channel of transmission (to rephrase it in terms known from transmission engineering).[503] Such material loss of information is compensated by the female allegory of Clio „writing" history: copying of symbolic letters is an almost lossless technology of tradition.

Tradition here means the separation of signal from noise by means of symbolic transcription. When we have ("received") a message which has somehow become scrambled with another, unwanted message (which we call noise), the challenge lies in "unscrambling these and restoring the original message with

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502 Annette Lavers (rev.), on: Michel de Certeau, Writing versus Time, in: Rethinking History. Time, Myth, and Writing, ed. M.-R. Logan / J. F. Logan, New Haven: Yale French Studies 59 (1980), in: History and Theory XXII, 3 / 1985, 330f
503 Claire Mays (NEA), in fact, points out that the scythe is not just a weapon but an agricultural tool as well; invasive cutting of agricultural plants is the condition of re-growing it. The scythe thus gives an extra sense to the dialectics of forgetting and re-generation (without memory).

as little alteration as possible, *except perhaps for a lag in time*"[504] - which is the problem of filtering.

[Correlation allows for a memory induced by the signals themselves; therefore Nuclear Magnetic Resonance, for example, is non-metaphorically at work in the concept of a ten thousands of years radio memory.[505]]

Towards the non-human observer: The media-archaeological point of view

Media archaeology is a method of enquiring into cultural time which is not limited to the historical (narrative) approach, that is: taking not exlusively of the human point of view on culture, but the perspective of technologies as well which themselves become active "archaeologists" of knowledge. Technological media machines produce articulations that do not necessarily need a human observer or translator any more in order to communicate between themselves.

Symbolic decoding (alphabetic "reading" and linguistic "undertanding" of the semantics of these strings of charactes) of an ancient Codex (e. g. the law code of emperor Theodosius) is not enough to grasp its historical significance, the historian R. G. Collingwood writes in *The Idea of History* (1946, 283). One must rather know and "re-encact" (not just analyze) Theodosius' contextual "situation".

On the other side, human "reading" becomes more and more machine-dependent. A groove on a vinyl record might still be "read" by a skill human interpreter (at least roughly), just like a slide of a micro-film compresses a text. Electronic recording (be it acoustic or optic signals, or textual symbols) requires refinded technology to be accessible for humans at all. Media archaeology is more akin to the gaze of the optical scanner that to that of the anthropological observer. Communication addressed to the future needs to take into account such non-human readers.

The aim of long-time depositories of nuclear waste is that the final disposal does not depend on human presence and intervention in order to fulfil its safety goal. Is this nessecary anti-hermeneutic, or does it lead to a re-freshed hermeneutics?

According to Hans-Georg Gadamer[506], the temporal gap which separates two cultural times makes it impossible for the latter to re-access the former unless they are linked by a common horizon of tradition ("wirkungsgeschichtlicher Zusammenhang"), e. g. a continuum of cultural sense from Homer to

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504 Norbert Wiener, Time, Communication, and the Nervous System, in: Annals of the New York Academy of Sciences, Bd. 50, 1948/50, 197-219 (205; italics W. E.)

505 On spectral correlation diagrams for time frequency detection (TFR) in signal analysis, see Boualem Boashash (ed.), Time Frequency Signal Analysis and Processing. A Comprehensive Reference, Amsterdam et al. (Elsevier) 2003, 505

506 Hans-Georg Gadamer, Wahrheit und Methode, Tübingen 1972

Heidegger. The "humanistic" paradigm relies on the hermeneutics of symbolically coded communication between distant spaces and across temporal distances. But beyond such understanding, Karl Popper declared a "third world" of knowledge which exists even in the absence of humans. The subjectivist point of view takes a book without reader for a meaningless object: "But logarithmic tables can be generated by a computer and be printed. These numbers may probably never be read by humans on earth. But each of these numbres contains what Popper calls "objective knowledge"[507].

Temporal invariance: the "humanistic" co-originality

Karl Popper reminds of a world of knowledge without a knowing (human) subject, reminding of Plato's notion of *anamnesis*. "Even though this <...> world is a human product, there are many theories in themselves and arguments in themselves [...] which have never been produced or understood and may never be produced or understood by men."[508] Popper imagines two apocalyptic scenarios: All machines and tools will be destroyed, as well as all human knowledge about such devices; only libraries survive and the human capacity to learn from them (depending on the reading / decoding / alphabetic capacity / literacy); thus the cultural world can be re-activated.

In an alternative thought experiment, even all libraries are detroyed: "there will be no re-emergence of our civilization for many milennia"[509]. There has been a scenario which actually happened: the destruction of the ancient library of Alexandria (which included, next to book rolls, a machine park and academic laboratory as well). Since knowledge was already embedded in machines, geometries und letters around the ancient world, the physical loss was a damage, but surprisingly not an epistemic loss, not desctructive to technical and cultural knowledge), since most of such mathematics and machines has been re-invented independently since several times.

"One of the main reasons for the mistaken subjective approach to knowledge is the feeling that a book is nothing without a reader: only if it is understood does it reallys become a book; otherwise it is just paper with black spots on it."[510] But "[...] a book, or even a library, need not even have been written by anybody: a series of books of logarithms, for example, may be produced and printed by a computer" (ibid.). Popper insistes on the "possibility or potentiality" of such prointed characters in a book of being understood, "and this potentiality of disposition may exist without ever being actualized or realized"[511].

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507 Popper 1972 / 1984: Karl R. Popper, Objektive Erkenntnis. Ein evolutionärer Entwurf, 4. Aufl. Hamburg (Hoffmann & Campe) 1984, 118f
508 Popper 1979: 116
509 Karl R. Popper, Objective Knowledge. An Evolutionary Approach, Oxford, 2nd. ed. (Clarendon Press) 1979, 108
510 Popper 1979: 115
511 Popper 1979: 116

"We may imagine that after the human race has perished, some books or libraries may be found by some civilized successors of ours (no matter whether these are terrestrial animals, which have become civilized, or some visitors from outer space). These books may be deciphered. They may be those logarithm tables never read before <...>. <...> it is sufficient that it might be deciphered <...> in order to belong to the third world of objective knowledge" (ibid.).

"Knowledge in this objective sense is totally independent of anybody's claim to know."[512] Even if the knowledge of so-called Pythagoras' early Greek physical experiments with the vibrating string (the monochord) or his mathematical reasoning with drawings of geometrical bodies ("Der Satz des Pythagoras") had been completely oblitterated by loss or destruction in the process of tradition, the rules would inevitable be re-invented. There is a co-presence which takes place in the physical respectively mathematical world, different from the contextual and discursive relativity of cultural (historical) human activity.

Across the temporal gap: The negentropic effort

Since the emergence of physical thermodynamics, statistical mechanics and mathematical stochastics in the 19th century, a paradigm shift for notions of cultural transmission took place. The humanistic trust into secure transmission of knowledge has since been replaced by the notion of improbabilities of transmission. Transmission of knowledge within the temporal domain, understood here in reverse to space-bridging communication channels, takes place in materially embodied and symbolically encoded forms. In this context "symbolic" does not refer to symbolism in its iconological sense of metaphorical meaning (such as the much discussed "markers" on nuclear waste sites[513]), but to discrete characters in coding information (ranging hitherto from alphabetic letters and Arabic numbers up to the binary code of Zeros and Ones embodied as Low and High voltage levels in electronic computing).

The very notion of "record" might be questioned in media-archaeological terms. The RKM *Glossary of Key Terms* defines a record as "an object or a selected piece of data / piece of information that has been committed to a medium". "Medium" is the term assigned by Claude Shannon's communication engineering to the channel of transmission. Let us understand communication here not in its vulgar sense as meaningful exchange but more formally as a sequence of signals and/or symbols. More specifically, information theory requires that something unknown is transmitted. In techno-mathematical terms, information theory which deals with temporal (in-)variances is close to correlation analysis. In order to compare a signal (*s*) at a (much) later *punctum temporis* with itself (*s'*), a correlator is required, which is based on means to store and to delay the signal.[514]

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512 Popper 1979: 109
513 See the OECD Radioactive Waste Management publication *More than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Mangement* (2010)
514 See F. H. Lange, Correlation Techniques, London (Iliffe Books) / Princeton, New Jersey (van Nostrand Company) 1967

Thus regeneration and relays are required. Different from traditional transmission as endurance where the massages was confined to one materiality (such as inscriptions in stone, or letters in the postal system), in dynamically encoded symbolic transmission the embodiment of information as signal may be variously *transduced*, i. e. change from one form of energy into another.

Information transmission (different from previous body- or paper-bound material messengers) is almost independent from its material signal (as defined in Norbert Wiener's *Cybernetics*).

In order "to counter the passage from negentropy to ultimate entropy", Thomas Sebeok proposed a "relay system" of information transmission, creating intervals by sampling: "to divide the 10,000-year epoch envisaged into manageable segments of shorter and, resumably, reasonably foreseeable periods"[515] which he counts by generations of humankind which would update the message periodically like relays in an electric communication channel.

Cultural knowledge is context-dependend (the so-called "historical" variable); that is why the RKM *Glossary of Key Terms* demands for a record that it is "kept together with the appropriate context and structure for later use"; whereas physical and mathematical laws claim invariance against temporal change in terms of ergodic behaviour.

The term *ergodic* defines "a stochastic process in which every sizable subsequence is the same statistically, and every state will occur in the long run"[516]. Ergodic theory had its origins in the work of Boltzmann in statistical mechanics problems where time- and space-distribution averages are equal.

"Culture is not based on direct replication"; by teaching and imitation. The transmission of culture is temporally extended."[517] The model of "tradition" as transfer in the time-based channel relies on the long-term persistence of records - be it "direct" or "indirect transmission", passing knowledge from one generation to another, known from "oral" cultures, or as data "migration" in digital preservation of records. This differs from a rather a-historical model of co-originality (German *Gleichursprünglichkeit*). Agriculture, e. g., was invented independently many times.[518]

The notion of "migration" itself points to a current shift of emphasis which is essentially connected to the discourse and physics of nuclear waste deposits: For long time already, the occidental fixation on "end"archives (eternal storage) has been replaced by the notion of intermediary, temporary, even ephemeral storage, the "Zwischenlager", leading to intermediary storage in permanence, thus: dis-locating the storage elements ("migrating" them in due intervals).

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515 Sebeok 1985: 464
516 Glossary of "Neural" Terms, in: Kohonen 1995, 253-281 (261)
517 Robert Boyd / Peter J. Richerson, The Origin and Evolution of Cultures, New York u. a. (Oxford UP) 2005, 378
518 Boyd / Richerson 2005: 355

Static continuous permanence (Bergsonean time) is being replaced by a dynamic concept of repeated actualisation: endurance by refreshing which is not only a principle in contemporary electronics (the electronic image in television and video; memory administration in computers) and communication technologies ("sampling"); this corresponds with the practice of archiving the Internet as well, as performed by the wayback-machine of the Internet Archive

To what degree is the endurance of knowledge dependent on material resistance to entropy? Direct transmission without intermediary agencies relies on the material endurance of records. In order to keep it meaningful (since "much cultural information is semantic knowledge"[519]), the medium itself here has to be made the message (McLuhan), independent of its original semantic content.

From a cult(e)urocentic perspective, a book without human reader might be a meaningless object: "But logarithmic tables can be generated by a computer and be printed. These numbers may probably never be read by humans on earth."[520] Jede dieser Zahlen verkörpert das, was Popper als "objektives Wissen" identifiziert. Jene "dritte" Wissenswelt, die nicht des menschlichen Subjekts zum Begriff bedarf, erinnert damit in der Tat an das Modell der anamnesis in Platons Dialog Menon. "Even though this <...> world is a human product, there are many theories in themselves and arguments in themselves [...] which have never been produced or understood and may never be produced or understood by men."[521]

"The architecture of the church may help store information about the rituals performed within. Without writing, however, the ability of artifacts to store culture is quite limited. <...> many artifacts are very difficult to reverse-engineer."[522]

Unless as oral literature, "[t]he vast store of information that exists in every culture cannot simply float in the air. It must be encoded in some material object"[523]. But what if information is not encoded ("written") in material storage media, but performed as modulation of dynamic signals, like speech or music in electro-magnetic radio transmission? Charles Babbage, the inventor of a mechanical proto-computer in Victorian London, once declared: "The air itself is one vast library, on whose pages are forever written all that man has ever said or woman whispered."[524]

Physical differes from logical permanence of documented information - between the (media-)archaeological monument and the historical document. "The European (Nordic) concept of preservation apparently relies on archival means and methods. To ensure a long term preservation of knoledge the U.S.

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519 Boyd / Richerson 2005: 423
520 Popper 1979: 115
521 Karl R. Popper, Objective Knowledge. An Evolutionary Approach [1972], Oxford, 2nd. ed. (Clarendon Press) 1979, 116
522 Boyd / Richerson 2005: 423
523 Boyd / Richerson 2005: 423
524 The Works of Charles Babbage, hg. v. Martin Campbell-Kelly, Bd. 9: The Ninth Bridgewater Treatise. A Fragment, 2. Aufl. 1838, London (Pickering) 1989, Kapitel IX, 36

researchers on the other hand focus on the use of markes or 'monuments' on the sites of the nucelare waste repositories."[525]

"Knowledge" in the RKM *Glossary of Key Terms* is defined as "the ability to understand and utilize the available data, information and records". The reader here obviously is meant to be human, but what if future readers are rather "robot historians" as suggested by Manuel DeLanda?[526] Let us extend this definition to Karl Popper's "third world of knowledge" as an inherent, physically or mathematically implicit form of knowledge in latency (waiting to be recovered or to be self-revealing (much beyond Polanyi's rather sociological notion of "tacit" knowledge). The alternative model to knowledge tradition thus is co-originality ("Gleichursprünglichkeit"), that is: the emergence of a same (or similar) knowledge anew at any given time, independent of its culturally transmitted knowledge (as indicated by the monumental formulaic "m = E/c^2" inscription at the COVRA nuclear site, The Netherlands which will faint parallel to the nuclear half-time, but implicitely remain intact as natural law).

Charles Sanders Peirce describes diagrammatic reasoning as such: "Similar experiments performed upon any diagram constructed to the same precept would have the same result."[527]

In order to decipher messages sent within the world of techno-mathematical knowledge itself, it requires something like DeLanda's "robot historian" indeed.

Mathematical knowledge here replaces semiotic decipherment. Semiotics as a branch of communication deals with the study of "the formulation and endoding of messages by sources, the transmission of these message sthrough channels, the decoding and interpretation of these messages by destinations, and their signification"[528].

The "mathematical theory of communication", though, is not concerned with the "semantics" of the transmitted signals; that is why "noise" here is not just a distortion but as well a possible source of information (just like in secret coding).

Nuclear time: radio-active memory

The essence of information is neither matter nor energy; in the RKM *Glossary of Key Terms* it is defined as "organized data that may or may not be recorded on a medium". Still it is dependent of signal embodiment either as matter (invasive "inscription", "record") or as energey (electro-magnetic waves as carrier for modulating radio signals).

Radio-active memory represents a special case which demands for more radical, daring theories and "radio"-based operations of knowledge

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525 Fryksén 1996: 326
526 Manuel DeLanda, War in the Age of Intelligent Machines, xxx 1991
527 Charles Sanders Peirce, Collected Papers, Bd. II: Elements of Logic, Cambridge, Mass. (Harvard UP) 1932, 350 <prüfen!>
528 As defined in Sebeok 1985: 451

transmission which is not limited to human understanding excluisvely any more.

Nucelar waste differs from previsously known material artefacts which are meant to be preserved for cultural memory by tradition in that it is matter which actively remains dangerous. This corresponds with a need for active (if not to say radio-active) memory. Active memory is known from the religious context as imperative memory, like in Judaism (*zachor*)[529] and Catholicism ("Tut dies zu meinem Gedächtnis").

In the case of radio-active deposits, we are not dealing with immobile materiality or passive symbolic codes, but with matter which is emits signals actively. Nucelar waste, by definition, is "radio" active; so why not take the radiation itself as basis for continuous signalling? "Every form of physical energy propagation can be used as a channel for conveing messages."[530]

Sonification might be an option of indicating the degree of radio-active decay itself - and not just "acoustically" coded images as in the case of the Voyager disc or acoustic records from noises, sound and ethno-music recorded on earth.

In the case of the copper discs attached to both Voyager space satellites (launched in August and September 1977) which was intended to carry messages from the earth to extra-terrestrial intelligence, the gold-protected aluminium record cover itself has been not only inscribed with diagrams to visually communicate information about human civilization but contained (and still contains, on its voyage in outer space) some ultra-clean Uranium 238 with a radio acticity of about 0,00026 microcurie. Its steady decomposition into its "daughter isotopes" turns it into a kind of radio-active clock, with a half live of about 4,51 billion years. An extra-terrestrial intelligence, by measuring the remnants of this sample might calculate and infer the time which has passed since that sample of Uranium had been fixed to the record cover.[531]

This kind of communication rests on natural, not cultural (arbitrarily coded) laws, on physical invariances - just like the mathematical formulas engraved and encoded onto the disc cover attached to the two Voyager satellites in 1977, just like the Search for Extraterrestrial Intelligence (the SETI project) involves the networked scanning of radio-astronimical noise to detect improbable messages inbetween, a future intelligence will detect such a regular noise pattern.

Present research detects far-distant echoes of the universal Big Bang - which in fact is tracing re-verberations. Let us take "radio" in its original, media-archaeological sense, thus turning its meaning into a tool for knowledge transmission. Radiation is a form of communication which transmits itself (creating its own "media" channel, the electro-magnetic waves).

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529 Yosef Hayim Yerushalmi, Zachor: Erinnere Dich! Jüdische Geschichte und jüdisches Gedächtnis, Berlin (Wagenbach) 1988
530 Sebeok 1985: 459
531 Carl Sagan et al., Signale der Erde. Unser Planet stellt sich vor, München / Zürich (Droemer & Knaur) 1980, 41

The nuclear time clock (Ernst Jünger)

In his book on the ancient art of time-keeping by sand - the hour glass - (a critique of the wheel-driven mechanical clock), Ernst Jünger reminds of tempor(e)alities which transcend the reach of mechanical clocks.[532]

Geological chronometry counts ultra-long temporal periods from layers of geological formations. A similar physics-based chronometry is based on the radiation caused by physical decay. The notion of "half time" in radio-active matter refers to the temporal interval in which the activity of a given radionucleid is reduced to its half; that is: half of the atomic kernels have been transformed - while emitting ioniciszing rays - into another nucleid. This temporal interval may range from micro-seconds to trillions of years; according to this range, the measuring tools and methods vary. "Die Erde wird als Uhr betrachtet, von der man die Weltzeit abliest" <200>. Jünger notifies the dialectic re-turn of such "elementary time" in clocks driven by atomic oscillations (quartz, atoms, electrons)[533] - which means measuring time from within the physical world, rooted within its measures and rhythms instead of simply being symbolic, that is: arbitrary cultural enactments.[534]

Depositories of radioactive waste embody a kind of "hot" nuclear clock indeed; the half-time values of radiation decay of uranium itself may serve as a long-time counter which - communicated *as* and *by* radio waves - is the message of the nuclear medium.

II MEDIA TEMPOR(E)ALITIES (notes):

Time-critical signal processing in humans and machines

- the time-critical *is* the temporal (in its etymological sense of "cutting, dividing")

- "The cinema is the truest time-art of all, since it most closely parallels the operation of time itself" = Gerald Mast, Film / Cinema / Movie, New York (Harper) 1977, 112; critique Bergson

- time-criticality differing from simply time-based processes; video art (Viola) as articulation of "Bergsonean" temporality and materiality; around 1900, with Henri Bergson, solid matter began to be perceived as a vibrating element; image as stable configuration dissolves into signal temporality of electronig image; temporal gap between technological and human perception opens;

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532 Alexander Rose from the Long Now Foundation insists that mechanical time keeping endures and is reconstructable, different from electronic clocking devices.
533 Ernst Jünger, Das Sanduhrbuch, Frankfurt/M. (Vittorio Klosermann) 1954, 200
534 "Diese Einheiten sind neu, aber sie sind zugleich uralt <...>. Sie beruhen nicht auf willkürlicher Setzung, sondern auf der Entdeckung kosmischer Rhythmen und Maßstäbe" <Jünger 1954: 202>.

video image, with its divisions into lines and frames, "is a living dynamic energy field, a vibration appearing solid only because it exceeds our ability to discern such fine slices of time" = Viola 1990: 44

- analysis of time-critical signal processing in systems, that is: both in animals and in machines, reactivating previous cybernetic assumptions under specific perspective of such micro-tempor(e)alities; Wiener's *Cybernetics* of 1948. Signal processing as a topic of applied mathematics - in the neo-cybernetic sense - does not refer to electrical engineering only[535]; time-varying quantities; sonography, electrocardiograms

Time-critical technical memories

- the temporal message of digital communication media in temporal deferal: from *live on tape* to media content *on demand*; temporal signature of webcasting: "Möglichkeit der Nutzer, jederzeit darauf zugreifen zu können"[536]

- disappears the clear distinction between what is present and what is past, what is transmitted "live" and what comes out of the archive

- memory *technically* defined as "a device into which information can be introduced and then extracted at a considerably later time" = Glossary, in: Edward B. Magrab / Donald S. Blomquist, The Measurement of Time-Varying Phenomena, New York et al. (Wiley) 1971, 314; close to what is known as a buffer in electronics. Minimal delay memories are at work in time-based and time-critical media even the more if we do not notice them. Drastically, these binary micro-memories dissimulate apparent "live" transmission by calculation in *real time*

Acoustic quanta in poetic prosody

- micro-temporal synchronization of instrumental play (one-string *gusle*) with real-time production of poetic articulation by the singer (*guslar* in Bosnia / Montenegro). Investigations into musical cognition turn (by Leman / Godoy et al.) media-archaeological with focus on the role of the measuring instruments / algorithms applied in identifying such servomotoric / cognitive correlations; computational ethnomusicolgy; technological agency and a/synchronicities induced by the *temporal* machine-human coupling

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535 See, for example, J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry (Hg.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 372-389

536 Andreas Bade, Radio im Internet. Zwei Wege für die "Stimme" im Netz, in: ders., Das Internet als programmbegleitendes Medium des Hörfunks. Historische Entwicklung von Internet, Radio und ihrer Medientheorien, Hamburg (Diplomica Verlag) 2009, Kapitel 3 (57-86), *online*-Veröffentlichung unter http://www.mediaculture-online.de

- prosody concerned with the temporal extensions of phono-poetic articulation; Aristoxenos, fragment of his rhythm analysis: temporal (*chronoi*) of prosodic variation, Delta-*t*; Lionel Pearson, Introduction II: The Greek Theory of Rhythm, in: Aristoxenus, Elementa Rhythmica. The Fragment of Book II and the Additional Evidence for Aristoxenian Rhythmic Theory, Oxford (Clarendon Press) 1990, xxxiii-liii

- "algorhythmics" (Miyazaki) within digital computer and digital communication (mobile telephony); new techno-prosody ("Dactyla")

- ancient Greek prosody based on time units ("acoustic quanta") rather than pitch accentuation; f*requency modulation* in radio technology vs. amplitude modulation : the temporal "Akkordeon", temporal extension and compression

- Béla Bartók's transcription of Salih Ugljanin's 1935 rehearsal of *Ropstvo Djuliç Ibrahima*: "Bartók faced the challenge of interpreting rhythmic groupings that had no archival body of traditional (art music) reference" = Foster; required a change from symbolic score notation (the "musical" regime) to sound analysis. "Notation <...> is unable to account fully for every tempo variation in art music"; *sonopoetic* momentum accessible in its eventality for time-critical analysis only by means of direct electro-magnetic transduction of phonographic records from the Sound Archive

Algorithmic "Tempor(e)alities"

- both "archiving the present" and "re-presencing the archive"; ambivalence of the present / presence; presence-generating media; complex notions of "live" transmission in television; healing prayer through the glass tube: http://forums.ssrc.org/ndsp/2013/04/10/tv-prayer

- algorithmic analysis / "Digital (post-)Humanities"; the techno-trauma becomes a techno-mathematical trauma. Interpreted with Alan Turing, "algorithmic memory" is the most post-human and the most human one at the same time (see his "Imitation Game"); the traumatic effect is rooted in the logic of computative algorithms (and Artifical Intelligence) itself, embracing both man and machine

- coupled with human perception, electronic and algorithmic media operations resulting in specific irritations of the human sense of time; techno-traumatic operations in the reproduction of presence ('representing') through technical media

- *aura* (as defined by Benjamin) depending on being "here and now"; technological temp*aura*lity and specifically its sonic articulations culminate in the archetype of photocentric presence, the voice

Just-in-time criticality

- Ilka Becker / Michael Cuntz / Michael Wetzel (eds.), Just Not In Time. Inframedialität und non-lineare Zeitlichkeiten in Kunst, Film, Literatur und Philosophie, München (Fink) 2011

- time-criticality as it relates to the rhythm of logistics, specifically the just-in-time production and distribution; the cultural technique (format) of the schedule (be it of bus timetables, train schedules, port schedules, order picking etc.) a symbolic precursor to time-criticality in digital media (communication Atle Kjosen, September 2014); Virilio in *Negative Horizon*: the schedule is the administration of time, different from analog "live" signal transmission

- within operative computing, algorithmic functions like the "interrupt" most crucial in that respect - microtemporal processes; High Frequency Trading at the virtual stock market

- anti-aircraft prediction in World War II as origin of what Norbert Wiener later termed *cybernetics*; just-in-time logics in computing: Is a problem solvable in polynomical time ("finite"); variance of *Halteproblems*, such as sorting algorithms; differs from human interval for identifying signal events and pulse trains as taking place in the present; three seconds within which they can be integrated and synchronized into a coherent impression; Alexander Grau, Zeitpunkte, Zeitfenster, Zeiträume. Wie das Gehirn unsere Wahrnehmung organisiert, in: Klaus-Dieter Felsmann (ed.), Der Rezipient im Spannungsfeld von Zeit und Medien, München (kopaed) 2008, 37-44 (41)

- so-called "temporal logic" is of intensional nature: formulas are evaluated not in abstract space from outside time (as in classical logic), but temporally local, i. e. at points of time. In propositional temporal logic, propositional elements can be either true or false depending on their point of time; first order temporal logic with "until" and "since"; D. Gabbay et al., Temporal Logic. Mathematical Foundations and Computational Aspects, vol. 1, O. U. P. 1994; H. Kamp, Tense logic and the theory of linear order, Ph.D thesis Univ. of Cal., LA, 1968; same author, Formal properties of "now", in: Theoria vol. 37 (1971), 237-273; Ian Hodkinson, Notes on games in temporal logic, URL

- in gaming, competitors struggle with topological lags in their Internet connections / LAN, and hardware / symbol processing devices (monitors)

- operative computer game analysis "The Physics of Pac-Man" (Stefan Höltgen); game studies in a media-archaeological way, ranging from "Flatland" (Abbott) and "wormholes" until the concrete code and storage address location in the RAM chips: Where is Pac-Man when he vanishes for seconds from the monitor edges?

- difference between the concept and reality of "real-time" as different from "live", or "immediacy"

Telegraphic immediacy

- Napoleon's network of 224 line-of-sight semaphore stations, spanning over 1,000 miles. "The coded message had to be repeated accurately at each

station [...] to get through. [...]" = Schwartz, Resonant Chord 1974: 3; required reinforcement (in the electro-magnetic Siemens telegraph relay sense)

- temporality of machines critical in terms of delays; while crisis of stock market in 1980s partly due to traders delaying answering their phone calls, nowadays nonhuman "calls"

- living part-time in the "off-line" mode, temporal gap opens between time stamp of message written into mail program at home and actual sending online at office

- physically, apparent immediacy of electromagnetic transmission not real, as identified by Maxwell's mathematical calculation of Newtons instantaneity model for propagation of such waves, and Hertz' experimental proof, which (unplanned) resulted in radio broadcasting

- immediate transmission as phantasmatic desire in early telegraphy, killing space by the effect of contemporary time (Heine); the very term tele*graphy* "re-mediated" the new communication medium to the well-known culture of alphabetic writing. Telegraphy is about sequential coding and decoding, strictly linear. But the electric "writing" of tele-graphy is coding time.

- real-time web a set of technologies such as *instant messaging* "which enable users to receive information as soon as it is published <...>, rather than requiring that they or their software check a source periodically for updates" = http://en.wikipedia.org/wiki/Real-time_web

- "dating" communication (known from postal letters in previous time on a calendar day basis, now escalates into "dating" the message down to the minute), f. e.: "On Monday, 23.05.2011, 00:26 +0200 wrote N. N. ..."; bizarre off-spring of this discourse term and practice of "speed dating", cutting short the temporal intervall which is integrated into what is addressed by the technical term "realtime"

Contemporary Condition(ing) in media culture

- any high-technological device a multi-temporal hybrid; different from the "diachronic" geological or archaeological layers (so-called "deep time"), a co-operativity. Since techno-logical regimes are co-originary, the components co-operate even if they stem from different techno-historical ages. A present automobile, e. g., "is a disparate aggregate of scientific and technical solutions dating from different periods. Once can date it component by component: this part was invented at the turn of the century, another ten years ago, and Carnot's cycle is almost two hundred years old. [...] the wheel dates back to Neolithic times. The ensemble is only contemporary by assemblage."[537] This is a techno-archival defining condition of our "historical present" - historicism, or present-in-the-past?

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537 Michel Serres, Conversations on Science, Culture, and Time, Michigan (Univ. of Michigan Press) 1995, as quoted here (as motto) in: Timothy Barker, Re-Composing the Digital Present, in: xxx, 88-103 (89)

- "[c]o-historicity" as abundance of technically mediatised and mediated pasts, histories and memories" = Martin Pogačar, Culture of the Past: Digital Connectivity, Co-historicity and Dispotentiated Futures, in: Andrew Hoskins (ed.), Digital Memory Studies. Remembering through digital and social media, New York (Routledge)

- time-critical processes where a temporal moment is decisive for the success of the action at all requires programming close to the machine: the microtemporality of the assembly language

- by digitizing archival records for present addressing *online*, the archive which formerly served as an enduring secluded "off-line" memory of legal claims, now changes to operative storage, techno-mathematically integrating past data to present consumption

- notion of the contemporary oscillating between the micro-politics of human subjectivity and machine time; being "radically present in the world now" = Aarhus project draft): *radix* (as mathematical operator, the square root) itself is a hint; the present is always already rooted in micro-temporal retentions (intermediary storage, as technologically active in early acoustic delay lines and even air as Delta-*t*), and electro-physically embodied in the accumulator for current power supply as condition for media mobility: ephemeral "storage" instead of permanent coupling to the grid, corresponding with the temporariness of mobile commbunication

- human "echo" experience analyses the aural presence of the immediate past and the schizophrenic and self-distanced presence; different from that phenomenological experience concept of contemporaneity understood as the coming together of different times in our "historical present", the "vehicle" of this coming together of different times is primarily the media

- in financial high frequency e-trading, emphatic "time" replaced by instantaneity: chrono-options. The figure of High Frequency Trading in the algorithmicized stock market is just the contemporary practice of a time-critical figure derived from techno-cybernetics in Second World War: the challenge of Anti-aircraft prediction, that is: anticipating the trajectories of an enemy plane or ballistic missile in "real time", that is: already in the present; Husserl re-/protention; "flash crashs" in HFT: irruption of temporal exception / faster than time / the traumatic "tempo*real*"

- the "contemporary" already split into "hyper-contemporary", optionalism based on the temporealities in the financial markets[538]; on the back cover of Armen Avanessian / Suhail Malik (eds.), Der Zeitkomplex. Postcontemporary, Berlin (Merve Verlag) 2016: a vertical column expresses the present condition with a double letter in the very beginning, thereby oscillating between the "CONTEMPORARY" and the "NONTEMPORARY". Temporality itself is obliterated, in favor or temporealities

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538 Elena Esposito, Die Konstruktion von Unberechenbarkeit, in: Avanessian / Malik (eds.) 2016, 37-42

Not to be confused: Media operativity and cultural bias

- abstract, quantitative time of watches and clocks took over the regime of qualitative religious time: "This homogeneous and desacralised time has emerged victorious since it supplied the measure of the time of work"[539], culminating in chronophotography (the precursor of cinema) and Gilbreth's media-technical measurements of smallest temporal units in working processes to optimize production.

- wheeled clock with mechanical escapement as opposed to simply mechanical clock; "to clock" or "to synchronise": beating, pulsing, oscillating

- investigate relation between media and religion not on the discursive, but on the technological level - the regime or hardware, media-epistemologically, technologies are indifferent to the question whether they have been installed out of a religious bias or not, even if they bear the imprint of this bias in technical form (just like the von-Neumann architecture of the programmable computer we use today still carries the genealogy of its original context: to create a machine which could calculate the triggering mechanism of the Hydrogene bomb, Los Alamos)

- media-archaeological revision of cultural history; relations between relgion and technology de-coupled by wheeled clock mechanism; not confuse religious practices with technological terms (association between liturgy and algorithm); what differentiates cultural techniques from genuine media technologies, insisting on the non-cultural element in technical media; cultural metaphors obscure media practice. Original divergence / non-"path dependency": oscillating clock resulting from late medieval monasteries; epistemological dis/continuity from religious timing to time-based media processes, resulting in differential oscillations (Leibniz et al.) which separate Pythagorean cosmology from electro-technical media age; mechanical clock "beat" stems from monastic Benedictine culture, but later emancipates knowledge from cosmic-religious time (heaven); Oresme's essay on planetary moves ("ciel")

- decisive mechanism defining the "truly mechanical clock" = North 1975: 392 from traditional astronomical mechanisms is verge or foliot escapement (such as Giovanni de´Dondi clock); later replaced by the pendulum. Periods of swing (oscillations) once restricted to observation of planetary systems for agricultural use, when mastered by mechanic knowledge, becomes fundamental parameter for micro-temporal events, opening media-operative measuring devices insight into a world of time-critical operations unknown to human perception (*aisthesis* / aesthetics) before. Media archeology not interested in ways in which oscillatory mechanism for both measuring time and striking a bell in the thirteenth century "was obsorbed into the high ritual of the church" = North 1975: 393; canonical hours of the monastic life - especially in the Cisterian rule where Rule XCIV asks for *horologium temperare* and *facere sonare* - almost inevitably / non-disursively induced "automatic control" = North 1975: 382 f.; desire to cause a clock to sound on its own, operates on a

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539 Henri Lefebvre, Rhythmanalysis. Space, Time, and Everyday Life, London / New York 2004 [* 1992], 73

level which is closer to science than to religion. Parallel to cultural *logos*, techno-logical reasoning at work; media archaeology uncovers that below the apparent cultural use a different kind of "epistemic thing" (Rheinberger) was established on a level sub-conscious to culture and religion: a training of sensibility to micro-temporal events. While the essence of "time" had been a favourite topic of analysis in early Greek philosophy and musicology, its media-technological reproduction by oscillaltory mechanisms follows a logics of its own

- symbolic ordering of time in liturgic rituals categorized under "cultural technologies", in decisive difference to genuine media opperations;epistemological discontinuity: separate religious timing from technical processes based on equi-temporal (periodic) oscillations (Huygens)

- technologies, once in operation, indifferent to whatever has been its cultural or discursive bias in their implementation, even if this bias has left an imprint in their technical form? Is there any correlation between procedural forms such as liturgy and algorithm? What differentiates the general cultural engineering of symbolic, even transcendental systems, such as religion, from genuine media technologies, namely, those based on the laws of physics or mathematics? Is there a noncultural, autopoietic element at work in technical media that escapes discursive (social) relativity?

- poetic oral articulation in distinct syllables / a temporal sense of measurable prosodic "beats"; only in the context of the medieval Christian European monastery that the cultural engineering of timing processes began to be implemented technologically; monastic prayer routines and working practices according to the Benedictine rule closely tied to a sense of periodic beats; not just cycles of the day or year (which vary in their duration) but also the prosody of liturgical chants or the rhythm of the gestures of work. Rolf Nohr states that "With the division of the day into distinct parts, each one fixed within an ordered framework of work and prayer, the order of monastic life became conceivably one of the points on which the framework of the rhythmic was established" = Rolf F. Nohr, Rhythmusarbeit, in: Britta Neitzel / Rolf F. Nohr (eds.), Das Spiel mit dem Medium, Marburg (Schüren, 2006), 225 (translation Michael Darroch); development of such mechanisms had the paradoxical effect of emancipating Occidental culture from its dependency on cosmic religious time. The attunement to periodic beats precipitated a decidedly nonreligious development, based on the growing knowledge and familiarity with oscillating mechanisms present in vibrating strings; same awareness led to the notion of "frequency" developed by modern acoustics and other forms of wave analysis, culminating most recently in the development of modern electronic media and in the timing mechanisms of computers. Deconstruction is technologically at work here; the escapement mechanism of the ticking, cogwheeled clock was a direct outgrowth of monastic rhythms, but that very technological development ultimately became a provocation to the liturgical world. Once the framework of monastic rhythms transferred to technological order of the ticking clock, bells no longer tolled for traditional cosmic time

- time as existential category to which religion and technologies have been giving decisively different answers; double-edged approach to modern techno-scientific practice as function of instrumental designs and functional properties

of specific technologies, its specific mechanical and mathematical capacities to compress or accelerate time, or to erase distance and reproduce sameness: features developed in differentiation from ritualistic experiences of time. Tracing phenomenologically imperceptible natural events rather than symbolically ordered time, media separate themselves from religion, just as the oscillating clock grew out of, then away from, the medieval monastery. Even if philosophers such as Newton and Leibniz, while applying the mathematical approach to the physical world, they also grounded themselves in firm metaphysical / religious beliefs concerning the order of the world, their techno-mathematical work autopoietically developed into a techno-mathematized world of its own

- traditional cultural categories of time challenged by current sampling techniques (e.g., digital signal processing) or by artificially setting a time base. What used to be mutually determinative relationship between religion and technology, turns into extremely divergent cultures of practicing time

Vibrating sense of time: between liturgy and machine

- "There is clocklessness, for sure, but no such thing as 'timelessness'"[540]

- "time does not mean watches, clocks or the oscillations of caesium atoms, time is not found in digital pips or paper calendars, time is not in pendulums or in chronometers; the clock is not a synonym for time but the opposite of time. The West's obsessive time measurement has gone hypertelic" = Griffith 12; Bergsonean argument

- cultural history discovers tight relations between religion and technology, with a seductive force to reformulate religious practices in technological terms = concept "cultural techniques" vs. non-cultural, techno-poetical element at work which is being focused upon by the close analysis of the Anchor escapement mechanism of the oscillating clock. While originating from the late medieval monasteries, its technical logic resulted in time-based media processes which challenge historical narrative itself

- media-archaeological event level (analogous to Braudel's tri-fold paces of time / *durée*), the regime of non-discursive technologies with an inherent logics of its own; technologies - once they are operative - indifferent to the question whether they have been installed out of a religious bias or not, even if they bear the imprint of this bias in technical form

- instead of reformulating religious practices in technological terms (association between liturgy and algorithm), precisely ask what differentiates cultural techniques from genuine media technologies, insisting on the non-cultural element in technologies (their inherent auto-poietical logics); epistemological dis/continuity from religious timing to time-based media processes, resulting in an awareness of differential oscillations (Huygens, Mersenne, Leibniz et al.) which separate the Pythagorean cosmology from the electro-technical and techno-mathematical media age
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540 Jay Griffith, Pip Pip. A Sideways Look at Time, London (Flamingo) 1999, 267

- "Lewis Mumford has suggested that the clock preceded the printing press in order of influence on the mechanization of society. But Mumford takes no account of the phonetic alphabet as the technology that had made possible the visual and uniform fragmentation of time" = McLuhan xxx: 147; ancient Greek interest in *cosmos* triggered insight into the relation between harmony and mathematics; phonetic alphabet gave a training in analytical thought (McLuhan); a sense of "beat" stems from the analytic discretisation of articulations as first pactices by the phonetic alphabet but led to its automated implementation on by need of religious monastic culture. Against Christian teleological sense of temporal linearity (later replaced by "arrow of time" inscribed by the 2nd law of thermodynamics into physical processes), transcendent time became *timing* once implemented in *operative* media

- phonetic alphabet rather corresponds with mechanical cinematics in its technical meaning, like the clock-work of timing relates to the mathematical position system of numbers: "Just as a great revolution in mathematics came when positional, tandem numbers were discovered (302 instead of 32, and so on), so great cultural changes occured in the West when it was found possible to fix time as something that happens between two points" = McLuhan 1964, chap. 15: "Clocks. The Scent of Time", 145-146 (145)

- "As a piece of technology, the clock is a machine that produces uniform seconds, minutes, and hours on an assembly-line pattern. Processed in this uniform way, time is separated from the rhythms of human experience. The mechanical clock <...> helps to create the image of a numerically quantified and mechanically powered universe" = ibid., 146

- sense of periodic repetition may have been culturally linked to liturgic practice but led to a rather non-religious take-off of oscillating mechanisms, from wheeled clock to "clocking" within electronic computing itself

Ruptures between cultural techniques and media technology

- technological inheritance not historically "past" but enduring not *in*, but *as* inherent archive (Foucauldean *l'archive*) of techniques and material constellations

- oscillating clock a nonhuman mechanism which conditions the rhythm of human bodies and minds, replacing mythic or religious temporal rituals; escapement mechanism in wheeled clock an epistemogenic artifact which differentiates cultural techniques from genuine media technologies

- literally time-critical criterion which emancipates media culture from traditional cultural symbolism: time measurement breaks loose from natural temporal perception and becomes a matter of the automated setting of time, in a rhythm freed from allegorical interpretations; difference between letterpress and handwriting as an analogy for the transformation enacted by the wheeled clock. As mechanical instruments, both letterpress and wheeled clock possess a central characteristic of technological media: the identical reproduction of elementary units of measurement. In contrast to rituals and liturgy,

mechanized time is no longer symbolically performative but rather technically operative; not time per se that is operative here, rather its implementation in a material artifact; Gutenberg's casting process for metal letters resulting in standardization of characters correlating with the wheeled clock in automation of temporal intervals

- Medieval Christian monasteries characterized by a peculiar representation of cyclical time (the liturgical year, the division of days into rhythms of prayer), resulting in need to regulate forms of living into liturgical "algorithms" by precisely quantified measurements of time in the form of hours of equal length (equinoctial hours); introduction of temporal beats an epistemologically fundamental inheritance of monastic culture, yet resulted in technically mediatized time, afterwards employed to undo cyclical time; mechanical beat became a criterion for literally separating medieval from modern time(s). Time, in this case, both subject and object of a media-archaeological *momentum*

Chronology, Clock, Rhythm vs. Monastic Planning of Time

- significant ancient Greek modification of Phenicean syllabic alphabet into phonetic alphabet by explicitely adding single letters for single vowels. Even if this must have happened at once peculiar instance by an individual creative act (Powell, *Homer and the Origin of Writing*), this still occurred anonymously in the media-archaeological sense. Gerhard Dohrn-van Rossum, History of the Hour, Chicago (University of Chicago Press) 1996: no explicit human intention manifested in the innovation of the "verge-and-foliot" escapement; in this key self-regulating mechanism that directed the motion of the late medieval wheeled clock, rather a techno-logics unfolds itself. In Benedictine monasteries, *a priori* no compelling interest in standardizing time through mechanically reproducible synchronization

- Leibniz may have subconsciously - according to his concept of *pétites perceptions* - had the binary pulsing of the ticking clock in his acoustic mind when he formulated his theological-mathematical dyad as a "wonderful origin of all numbers from 1 and 0, which offers a beautiful model of the mystery of creation, for all things originate from God and otherwise out of nothing: *essentiae rerum sunt sicut numeri* = Letter from Leibniz, 18 May 1696, quoted in Hans J. Zacher, Die Hauptschriften zur Dyadik von G. W. Leibniz. Ein Beitrag zur Geschichte des binären Zahlensystems (Frankfurt/M: Klostermann, 1973), 209

- becoming quasi-mechanical, human bodies disciplined and manipulated on the temporal axis; yielded a microphysics of power in the form of temporal rhythm; synchronized time measurement (as in the coupling of clockwork and photography, e.g., in chronophotography) ultimately facilitated a form of media-technical analysis of movement that would finally produce a re-synthesis, in the form of cinema

- "continuously ticking" (oxymoron) since the second half of the thirteenth century, the wheeled clock, equipped with a verge escapement mechanism that controlled the advancing gear train at regular intervals or "ticks", put into practice a negentropic dissection of the flow of time, analogous to the

spatialization of the printing press. In lieu of the constant, analog character of the sundial indicator, the pulse of the mechanical clock was balanced through even intervals of the taut (and thus stored or potential) energy of a weight. As the verge escapement forced time constantly to expend itself, the seeming continuity of time was subdivided into even segments, a folding together of the analog and the digital; an early form of the binary implementation (informatization indeed) of mechanical processes as they had been known ever since mill wheels; regulation based upon an interruption: kind of material embodyment of zero at the temporal level; Peter Gendolla, Die Einrichtung der Zeit, in: Christian W. Thomsen / Hans Holländer, eds. Augenblick und Zeitpunkt (Darmstadt: Wissenschaftliche Buchgesellschaft, 1984), 49; once zero was calculated as a gap (a condition of the positional notation system), clock ticked at regular intervals

- highly literate communities apt fpr accepting the fragmentation of life into minutes and hours = Marshall McLuhan, *Understanding Media. The Extensions of Man* (New York: McGraw Hill, 1964), 142; time conceived as something radically discrete: a virtual differential. However, "it was not until printing extended the visual faculty into very high precision, uniformity, and intensity of special order that the other senses could be restrained or depressed sufficiently to create the new awareness of infinity" = Ibid, 112; accompanied the idea of the research experiment, as well as the "concept of indefinite repetition so necessary to the mathematical concept of infinity," which ultimately culminated in Leibniz and Newton's infinitesimal calculus = ibid, 112

- static aesthetic of order in the concept of the cosmos became a dynamic wheel with a wheeled clock. Nicole d'Oresme preoccupied with the relationship between uniform and nonuniform movement, directly anticipating the infinitesimal calculus that transferred every type of space or movement into a continuous space. With advancing precision, temporal intervals infinitesimally converged on zero. Temporal perception was thereby mechanically specified, and later cast by Newton and Leibniz into mathematics. In our day, the computer is clocked by the ultra-fast oscillations of an electrically activated quartz crystal—down to units that escape human perception and that allow infinity to reappear in the infinitesimal

- ticking, wheeled clock signified that numbers were turning into machines (or that machines were becoming numbers), starting to prepare us for the advent of the Turing Machine, the modern computer of the twentieth century

- wheeled clock transforming Medieval "annalistic" macro-time into a microphysics of time

- Aristotle, in a techno-constructivist rather than phenomenological way (St. Augustin) defined time as motion to which numerical values can be assigned by measuring; concept of an estimated vanishing point in alliance with zero in mathematical calculation, producing a linear temporal perspective. With the advent of the wheeled clock, a rhythmic mechanism began subliminally to massage (in McLuhan's sense) the human sense of time, and its message came to be that the world could be perceived in terms of frequencies. The precise countability of time as movement (beginning with the ticking clock) eventually yielded world images such as those of film and line-synchronized electronic

television. From this point, an advanced mathematical sense of time come into play: Leibniz' and Newton's infinitesimal calculus, which finally was related explicitly to the electronic media by Norbert Wiener = Norbert Wiener, *Cybernetics or control and communication in the animal and the machine* (Cambridge, MA: MIT Press, 1948)

- With its mechanical escapement, wheeled clock produces precise temporal prosody in the form of a pulse sequence, with equal intervals; based on such oscillations, machines later generate audible sounds in technical form; sonic existence came to take place as being in time; "ringing gradually begins to break away from the geometry of monochord proportions; music begins to leave the space of Greek mathematics, to plunge into the eventful dimension of time" = Wolfgang Scherer, Musik und Echtzeit: Zu John Cages *4'33*, in: Zeit-Zeichen. Aufschübe und Interferenzen zwischen Endzeit und Echtzeit, eds. G. Christoph Tholen and Michael O. Scholl, Weinheim (VCH Acta Humaniora) 1990, 351-362 (356). This dimension can be called "media time." In his *Syntagma Musicum* (1614-1620), the organist Michael Praetorius related the symbolic order of the length of notes to the mechanical beat of the wheeled clock; Grete Wehmeyer, *Prestississimo. Die Wiederentdeckung der Langsamkeit in der Musik* (Hamburg: Kellner, 1989), 15

- metronome of Johann Nepomuk Maelzel (Vienna 1814), musical beat found its own medium, setting the terms on which the micro-time of physical acoustics would later become comprehensible through electro-technical measurement, "the necessary greater exactness [of which] is obtained by the electric current itself" = Hermann von Helmholtz, On the Sensations of Tone as a Physiological Basis for the Theory of Music [GO 1863], Whitefish, MT (Kessinger Publishing) 2005, 398; also Scherer 1990: 362. Ultimately, the electronic oscillatory circuit released the beat of time from all cosmic-religious remnants, in order itself to radiate in the ether.

- in Pythagorean aesthetics, harmony of integer numbers applying both to tonal oscillations and to planetary motion; with the development of the pendulum clock, mathematical counting of movement becaming autonomous, as a metronom to measure time; in 1377, Nicolas d'Oresme comparing movements of the celestial bodies with a wheeled clock in his *Libre du ciel et du monde* = Nicole Oresme, *Le livre du ciel et du monde*, edited by Albert D. Menot, Madison, Wi. (University of Wisconsin Press) 1968; specified the decisive element of the wheeled clock as the mechanical correlate to the ancient harmonic theory of the cosmos. Once set in motion by God, this system runs automatically. Even Leibniz conceived of his monads as clocks wound up by God: they "continued to keep time with one another like separate clocks, so that they appeared to communicate with one another; but this appearance is merely a deceptive consequence of their synchrony" = Norbert Wiener, Time, Communication, and the Nervous System, in: Annals of the New York Academy of Sciences, 50 (1948-50), 207; monads thus conceivable only *via* the wheeled clock as a standardized and standardizing instrument of measurement that also produced comparability in time. Norbert Wiener writes: "As a matter of fact, the automata made in the seventeenth and eighteenth centuries were run by clockwork," and today, more than ever, computing demands highly sensitive pre-existing temporal harmonies = ibid.

The Epistemogenic Artifact: the Wheeled Clock Escapement

- earliest mechanical clocks still retained principle of continuous driving force, such as water clock and in the water wheel. "It was about 1300 A.D. that the step was taken of momentarily interrupting rotary movement by a crown rod and balance wheel. This function was called 'escapement' and was the means of literally translating the continouous force of the wheel into the visual principle of uniform but segemented succession" = McLuhan 1964: 153

- "It was not the clock but literacy reinforced by the clock, that created abstract time and led men to eat, not when they were hungry, but when it was '*time* to eat'" = McLuhan 1964: 154

- in verge escapement of the wheeled clock, a technical mechanism became epistemogenic matter; description of the escapement's media-historical moment provides occasion to reflect upon some of the methodological implications of media archaeology; technically precise explanations carry epistemological weight; the art of media-archaeological (rather archaeographic) *ekphrasis* - comes into play; how escapement works: without such an intermittance, rotation of the axle would steadily increase in speed. "A crown wheel with an uneven number of teeth, mounted onto the axle or linked to it via a gear train, . . . alternately blocks and releases the verge by means of two pallets attached to the verge at a right angle to each other. . . . The duration of the oscillation of the inertial mass of the verge and the foliot can be adjusted by moving regulating weights on the foliot. . . . This to-and-fro, oscillating movement inspired terms for the device such like 'restlessness', 'foliot' (from a word describing a quivering leaf, first used by J. Froissart around 1370), even most metaphorically 'women's temperament'" = Dohrn-van Rossum 1996: 53; culture of the early modern period not only struggled with a new technology but also with a new language for describing it. Classical art of description had originated in rhetoric, based on linguistic figures; in contrast, new type of technological objects that emerged in early modern Europe demanded a new type of representation: the language of mathematics and of the technical diagram

- decisive feature of mechanical clockwork contained stored-up energy; spring tension produces pressure on the escapement mechanism, distributing minimal energy quanta into equal oscillations, which were then transformed mechanically into beats, placed on the border of pure information. Despite such a radical departure from existing clock technologies, introduction of the verge-and-foliot escapement barely mentioned in contemporary sources; only in retrospect described as "significant but mysterious", precisely because its mechanism could not be perceived at the interface of the clock face = Dohrn-van Rossum 1996: 46. Technical media achieve their effect by dissimulating their mechanisms: "In contrast, the appearance of striking clocks was registered instantly, and was felt to be technologically sensational and socially momentous" = ibid. Whereas the clock face can immediately be seen and heard, generating the effect of an advancing time, a glance at the escapement suggests an alternating oscillation rather than linearity; escapement thus constituted the first binary mechanism of positive/negative polarity, which ultimately became operative in electrical clocks and electronic clocking devices

- technological artifacts worthy of investigation in terms of their epistemic implications for media culture; every operative technology apt for media theory. Respective to their material substrates and logical diagram, technical media, like the science that studies them, not purely discursive events. In contradistinction with the objects of classical archaeology, medial-epistemic matters are logical as well as material artifacts. Techical media manifest themselves exclusively through their operations, placing logic next to hardware and making the term *techno/logy* meaningful

- first generation wheel clocks ticked rather imprecisely; uniform oscillations of the horizontal pendulum (the foliot-escapement with verge) independent of the precisely wrought wheelwork of the clock. Improvements in the accuracy of time measurement achieved with Galileo's discovery of the laws of pendulum motion in 1641 and with their application to the design of a free, vertically oscillating pendulum by Christian Huygens in 1656. Huygens's pendulum escapement established a new basis for measuring time: the periodic oscillation itself, which as a unit of measurement remained valid through to the invention of the atomic clock in the twentieth century, which approached the oscillatory operations of sensory data processing in the human brain = Ernst Pöppel, Die Rekonstruktion der Zeit, in: Hannelore Paflik (ed.), Das Phänomen Zeit in Kunst und Wissenschaft, Weinheim (VCH) 1987), 29 f.

- ticking wheeled clock not an allegory of time but a time machine; its presence acoustically indicated by the striking mechanism; because its technical mechanism in most cases remains hidden from the observer behind the clock face (*dissimulatio artis*, or concealment of technology, as basic techno-rhetorical figure of all media effects), requires media-archaeological attention.

- principal work of such a clock called, in a telling *terminus technicus*, "timework"; hour-striking mechanism (and deriving from it, musical compositions programmed *via* a cylinder with pins) controlled discretely / digitally. Otherwise, on the visible "analog" surface, motion of time appeared continuous. In the form of kinetic notation, the clockwork might be portrayed in diagrammatical terms: a kind of programming *avant la lettre*; Franz Reuleaux, Theoretische Kinematik. Grundzüge einer Theorie des Maschinenwesens, Braunschweig (Vieweg) 1875

On the Ritual and Liturgy of the Wheeled Clock: Media Archaeology versus Media Anthropology

- ticking clockwork resulting in an abstraction from cosmic time that could still be experienced empirically; mechanism of the verge-foliot escapement allowed the motion of a weight-driven axle to be controlled in such a way that its uniform rotation became suitable for use as a time standard such as the equinoctial hour in Benedictine monasteries = Dohrn-van Rossum 1996: 48; wheeled clock became a chrono-poietic (time-giving) instrument and established a time abstracted from nature. "For the first time in world history, mechanical reproduction emancipates a work of art from its parasitical dependence on ritual", Benjamin remarks on photography = Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit, Frankfurt

(Suhrkamp) 1963, 17; also Jonathan D. Kramer, The Time of Music, New York / London (Schirmer) 1988, 68; such emancipation had already occurred within the temporal regime

- ceremonial, ritual, rhythm, and repetition all cultural techniques for making time symbolically steady = Hartmut Böhme, Vom Cultus zur Kultur(wissenschaft). Zur historischen Semantik des Kulturbegriffs, in: Renate Glaser and Matthias Luserke, eds., Literaturwissenschaft - Kulturwissenschaft. Positionen, Themen, Perspektiven, Opladen (Westdeutscher Verlag, 1996, 55; culture practices as negentropic expenditure of energy: maintaining symbolic order against the second law of thermodynamics, according to which particle movements tends towards equal dissipation *alias* disorder

- culture technical in its sense of standardization and ritualization, but only with the escapement-controlled wheeled clock did media time emerge in a well-defined sense. Even if ritual and ceremony already represented a form of temporal regularity and performance, those instructions were still like handwriting in comparison to typography / machine writing: variable in their concrete theatrical manifestations; in the working world of modernity, "ritual is replaced by the precise, technical operation" = Ernst Jünger, Über den Schmerz, in: Blätter und Steine [orig. 1934], 2nd ed. Hamburg (Hanseat. Verlagsanstalt) 1941, 208

- technological *routine* ("path of habit") denotes a "fragmenting of work into simpler motor functions that can slowly be combined" = Hugo Münsterberg, Grundzüge der Psychotechnik, Leipzig (Barth) 1914, 559; in discrete, digital systems "[a]ny step is [. . .] as important as the whole result" = John von Neumann, General and Logical Theory of Automata, in: idem, Collected Works, Vol. V: Design of Computers, Theory of Automata and Numerical Analysis, ed., A. H. Taub, Oxford (Pergamon Press) 1951, 292

- escapement-controlled timepiece much more than a trivial mechanism but a cybernetic, that is: feedback-regulated system; in order to understand its isolation / autonomy from its human setting requires forgetting that it was made in the first place in response to specific human needs = J. D. North, Monasticism and the First Mechanical Clocks, in J. T. Fraser and N. Lawrence, eds. The Study of Time II. Proceedings of the Second Conference of the International Society for the Study of Time, Berlin / Heidelberg / New York (Springer) 1975, 381; once such a mechanical clock is put to work, its functions depend on a genuinely media-governed logic, indifferent to whether it is being applied in a medieval monastery or in a present-day museum; message of this media mechanism is not only the acoustic signal that human ears decode as an indicator of temporal measurement, rather a media-physical reminder of frequencies and oscillations, rhythm and repetition as basic media-archaeological ingredients

- innovative media-epistemological feature of the mechanical clock, the coming into being of the mechanical escapement in the thirteenth century, as much bound to moments of cultural history as to techno-logical laws operating in an ahistorical temporal register, and its "tradition" is as much a function of the survival of knowledge about wheel-driven clocks (astrolabes) from antiquity

into medieval times as it is part of a techno-logical self-reference that is only partly identical with the discursive variations of human history

- verge-and-foliot escapement = decisive mechanism that distinguished the "truly mechanical clock" from traditional astronomical mechanisms; *later* (or functionally) re-/displaced by the pendulum. Periods of swing (oscillations) been part of cultural knowledge but restricted to the observation of planetary systems for agricultural use, became fundamental parameter in the measurement of micro-temporal events; insights of media-operative measuring opened up a world of time-critical operations hitherto unknown to human perception (in the original sense of *aisthesis*). Media archaeology does not aspire to explain the ways in which the oscillatory mechanism used for both measuring time and striking a bell in the thirteenth century were absorbed into cultural discourse such as the high ritual of the church. The canonical hours of the monastic life—especially according to the Cisterian rules (such as Rule XCIV, which referred both to *horologium temperare* and *facere sonare*) —almost inevitably engendered the demand for some sort of automatic control. With clockwork, control was given over to the time of automata. But the driving energy behind the development of the mechanical clock—the desire to cause a clock to sound on its own—operates on a level that is not restricted to religion. Parallel to the unfolding of cultural logic, something else is at work. Media archaeology pays attention to what was established on a subconscious level prior to culture and religion: the training of a sensibility to micro-temporal events

The Anachronism of the Ticking, Wheeled Clock

- chronological origin of the time-giving mechanical escapement-driven clockwork itself literally "escaping" historical narrative: "No entry in a chronicle, no narrative account, no description of the construction makes the invention an event we can date or locate" = Dohrn-van Rossum 1996: 46; early weight-driven clock in Cathedral of Strasbourg, built by Henri de Vick (Wieck) between 1362 and 1370. Around 1320, Dante Alighieri describes in the *Divine Comedy* a wheeled clock with a mechanical escapement. Notwithstanding such references, invention of the verge-and-foliot escapement-driven clock belongs to what Sigfried Giedion describes as anonymous history = Siegfried Giedion, Mechanization Takes Command, Oxford (Oxford University Press) 1948. Although an astronomical clock furnished with a kind of escapement mechanism had already been introduced into China in the year 1092, Gerhard Dohrn-van Rossum considers the foliot escapement as "in all likelihood an independent European development" = Dohrn-van Rossum 1996: 105; strictly media-archaeological argument. Chinese clock contained an escapement made by pivoting: "balance levers that stabilized a stop-and-go motion. The principle of the European escapement, which employs the centrifugal force of an oscillating inert mass, does not resemble it in any way whatsoever" = van Rossum 1996: 87. Only on a technically close reading does this difference come into view. As Joseph Needham writes, "We cannot rule out the possibility of completely and independently parallel lines of thought occurring in widely separated parts of the world" = Joseph Needham, The Shorter Science and Civilisation in China, Vol. 1, ed. Colin A. Ronan (Cambridge: Cambridge University Press, 1978), 58. Therefore another temporal order, one that reacts

asymmetrically to the temporal economy of telling the "origin" of the escapement as a moment precisely registered in historiography; media archaeology refers more to the discrete time of machines as to the symbolic time of human culture called "history". The digital beat of clockworks and the discrete series of letters in archival records are different kinds of non-narrative temporal information.

- wheeled astronomical clock at St. Mary's Church in the city of Rostock still ticking today; has been preserved in its original form and is fully functional since 1472, with parts of its mechanics incorporating a precursor clock from 1379; Manfred Schukowski, Die astronomische Uhr der St.-Marien-Kirche zu Rostock, Rostock (no publisher indicated, brochure) 2004, 4. The constant ticking of this clock questions the (self-)temporality of such chronomedial systems: a kind of media time that escapes the discourse of history. Media archaeology involves an effort to capture this media-inherent microcosm of time.

"Nor is it fitly said, 'There are three times, past, present, and future'; but perchance it might be fitly said, 'There are three times; a present of things past, a present of things present, and a present of things future'" = St. Augustine, The Confessions of St. Augustine, Bishop of Hippo, Book XI, Chapter XX, trans. and annot. J. G. Pilkington, Edinburgh) (T. & T. Clark), 1876, 306. Augustine thereby implicitly describes the condition of an intact clock. Among the peculiarities of technical media is the fact that they behave negentropically toward the flow of time. Technical media reveal their essence only by occurring in the present. All *arché*, all origin, is dissolved in this taking place; historicist notion of the "Middle Ages" dissolve into the tick of the wheeled clock as it takes place today

- escapement-driven wheeled clock the opposite of a mnemonic medium: its stored energy (the wound-up metal spring) is a physical-energetic memory, intermittently converted into information (time designation) and comparable to the electromagnetic relay used in binary digital memory. Technological time and historical time differ fundamentally. Commenting on paragraph 80 of Martin Heidegger's *Being and Time* (1927), the chapter concerning clocks, Friedrich Kittler notes that Heidegger did not haphazardly switch from a fundamental-ontological description to a positivistic, cultural-historical description. According to Kittler, Heidegger's dilemma was this: "A history, which is essentially time, intersects with another history, through which the machines of time-measurement themselves pass. Clocks are ontic devices, thus subordinated to fundamental ontology, which nevertheless bring about historically different ontologies" = Friedrich Kittler, Eine Kulturgeschichte der Kulturwissenschaft, Munich (Fink) 2000, 235 f.

Hindrance time

- abstract, quantitative time of watches and clocks took over the regime of qualitative religious time; "homogeneous and desacralized time" (Henri Lefebvre), culminating in chronophotography, the technical measurement of the smallest temporal units in working processes in order to optimize production" = Henri Lefebvre, Rhythmanalysis:. Space, Time, and Everyday

Life, London / New York (Continuum) 2004, 73; replacement of metaphysics of a continuous time by a model of discrete pulsing represents not only a culturally historic but also an epistemological shift. In Occident, time of clocks literally introduced bit by bit, with this phrase being more than just a wordplay

- What appears on the "analogue" clock face as a smooth temporal progression (unless indicated by second index) dissolves into "digital" machine counting from a media-archaeological perspective; metonymically, the view of the clockwork itself. In Heidegger's words: "Time is not. There is, It gives time. The giving that gives time is determined by denying and withholding nearness" = Martin Heidegger, Time and Being, in: idem., On Time and Being, trans. Joan Stambaugh (Chicago: University of Chicago Press, 2002), 16

- infinite or negligible impedance between the two poles of a switch technically called *hindrance*. Its mechanical precursor is the escapement. Through the functioning of the escapement, time counts in binary form. What alphabetic writing accomplished for the phonetic stream of speech, the wheeled clock achieved for time: a radical individuation, a core of occidental combinatory rationality. Ultimately, the sampling practice of signal engineering is at hand, in which individuation means the replacement of an infinity of consecutive values with a finite number of values; Claude Cadoz, Les réalités virtuelles (Paris: Flammarion, 1994), 85. Such a quantification of values changes its temporal essence: "Between 0 and 1 there is no time. . . . It is the hindrance that gives the 'discretized' [*diskretisierte*] time" = Bernhard Siegert, Passage des Digitalen. Zeichenpraktiken der neuzeitlichen Wissenschaften 1500-1900, Berlin (Brinkmann & Bose) 2003, 9; also Claude Elwood Shannon, A Symbolic Analysis of Relay and Switching Circuits, in: Transactions American Institute of Electrical Engineers vol. 57 (1938), 713-23; tick of the clock that originated in the monastic order returns in the time-discrete formation of digital computing. In the guiding principle of the so-called von Neumann-architecture for computers, commonly in use today, this sense of time is still operative. "One thing at a time, down to the last bit!" = William Aspray and Arthur Burks, Computer Architecture and Logical Design, in: William Aspray / Arthur Burks (eds.), Papers of John von Neumann on Computing and Computer Theory, Cambridge, Mass. (MIT Press) 1987, 5 f.

Bulova Accutron

- tuning fork, coupled to an electro-magnetic coil (as developed by Hermann von Helmholtz as electro-mechanic device to measure the micro-temporal run time of nerve impulses), provides the time base in the Bulova *Acutron* watch; German "Stimmgabeluhr", formerly advertised: "The Tick vs. the Hum". A sine tone here serves as time-giving media event - not for acoustical or even musical sake, but in implicit sonicity: the tempor(e)ality of sound which is shared by processual technologies

- non-metaphorically, core agency of synchronization is communication between nonlinear oscillators which adjust heir rhythms due to weak interaction. Literally, "emerging synchronization" has been Christiaan Huygens' 17th century observation of two pendulum clocks suspended in the same wooden beam whose motions were "so much in agreement that they never

receded the least bit from each other and the sound of each was always heard simulateneously" = Horologium Oscillatorium, as quoted in: Michael Rosenblum / Arkady Pikovsky, Synchronization: from pendulum clocks to chaotic lasers and chemical oscillators, in: Contemporary Physics, vol. 44, no. 5 (September / October 2003), 401-416 (401). By such *coupling*, the implicit "sonicity" of synchronization (named "le phénomène de la sympathie, sympathie des horloges" by Huygens = quoted ibid.) becomes explicitely acoustic. "These features are typical not only of clocks, but also of many oscillating objects of diverse nature" - generalized sonicity <402>. "Mathematically, such an oscillator is described by an autonomous (i. e. withpout explicit time dependence") nonlinear dynamical system" <402> = invariant in regard to "historical / cultural" time, rather *eigenzeit*. Beyond acroamatic fixation of that time-critical phenomenon to the audible by human ears, the effects was applied by E. V. Appleton and B. Van der Pol to exact triggering of vacuum tube triode generators as basic condition of radio electronics; soon afterwards in 1920, W. H. Eccles and J. H. Vicent "coupled to generators which had slightly different frequencies and demonstrated that the coupling forced the system to vibrate with a common frequency" = Rosenblum / Pikovsky: 402. Obviously, "the frequency of a generator can be entrained, or synchronized, by a weak external signal of a slightly different frequency" = ibid.; *entrainment* therefeore does not only relate to the adaption of human neurons to musical rhythm.

- not confuse such synchronization with another phenomenon in oscillatory systems which is resonance: the response of a system that is non-active, i. e. demonstrates no oscillations without external driving, different from self-sustained oscillations without external forcing - such as the radio-controlled clock where the radio signal from the sender is meant only to adjust or correct the oscillations, vs. the railway station clock which actually stops when the electric impulse from the central master clock ceases <403>.

- in chaotic multi-oscillatory systems, emergence of local synchronization <412> which can be observed on the oscilloscope (Lissajous-like figures for synchronous regimes, vs. random distribution for the asynchronous regimes) = 406, fig. 4; cp. Chua oscillator; T. Matsumoto, A chaotic attractor from Chuas's circuit, in: IEEE Transactions on Circuits and Systems, 31/12 (1984), 1055-1058

- tuning fork-based electronic clocks driven by frequencies within the audible range ("tonfrequent", 360 Hz /cps) - in reverse of philosophical or aesthetic speculations on "time and music"; ends with the subsequenz Accutron 2 series with quarz crystals as clocking device: ultra-sonic. But here is still sound, this time implicit; centre of this system = piezoelectric *resonator*

- Shaul Katzir, War and peacetime research in the road to crystal frequency control, in: Technology and Culture 51 (2010), 99-125 http://humanities.tau.ac.il/segel/skatzir/files/2012/03/TC-Cady-published3.pdf; impossible without valve / transistor electronics; Cady's discovery: quartz crystals display very sharp / stable electric resonance. Resonance, as expressed by the very *terminus technicus*, implicit sonicity: the tempor(e)al of immediately coupled system when addressed in their *eigen* frequency; resonant circuit (German "Schwingkreis") as basis for radio & television (and current mobile communication) devices; Bell Labs searched for highly accurate / stable method for measuring frequency rather than time; underlying

media-theoretical bias: replace the despotic, transcendent signifier TIME by the plurality of dynamic events actually taking place

- to coordinate / synchronize complex communication networks, American Telephone and Telegraph Company / national laboratories determined / maintain common standard frequency measurement unit.   Exploiting novel piezoelectric quartz methods and electronic circuits, new crystal-based frequency standard

Electricity: The media-archaeological index of McLuhan's media theory

- electronic speed of wireless or cable-based commmunication such as telephony not involving material / mechanical transportation vehicles any more, with its "electrons" being almost completely liberated from matter and energy and rather taking place as world of contiguous pulses; in the world of electronics, speed not conceived as conquering of space (movement) any more but as ultra-short temporal moments

- McLuhan's analysis of electrically configured media / Paul Virilio's dromology; speed at which information travels, undoing spatial distance by almost synchronous communication, "the electric environment of instant circuitry" = McLuhan 1964: x, where "the action and the reaction occur almost at the same time"; speed-up of information flow with electricity-based media which McLuhan opposes to the "linear" communication diagram of Claude Shannon. What he did not anticipate was bit-based media which can emulate and even undertunnel electronic speed by mathematical intelligence to what we now call *real time*. (and the so-called Real Time Internet).

- McLuhan interpreting electronically mediated communication as a contraction of the global world into pure tele-presence; this contractions not primarily a spatial one but of a temporal nature. This does not mean an alienation of humans from nature by techno-culture but, on the contrary, his coming-into-being: The electric age, according to a guiding thesis in McLuhan's *Understanding Media*, has technically extended the central nervous system, thereby creating a techno-communicative society from within

- in times of Internet protocols, McLuhan's thesis requires closer reading; what he has described metaphorially then has become literally true. Time-critical processes take place in its most media-archaeological sense, that is: on the basic layer of bit transfer in the, the *physical layer*. This layer represents the interface of symbolic transfer to the material (or electro-magnetic) channel of communication (such as copper cables, wireless directions, light waves lines) and thus embodies very concretely the interlacing of logi(sti)cs and matter which is already implied in the term "technology". It is on this layer that the voltage level of what is meant to represent a logic "zero" and a logic "one" is being defined. The function of this bit transfer layer is in the transformation of signals within a physical transfer channel into information in order to be passed further to level two of the OSI system.[541] This identification of signals happens

541 Christoph Neubert, Elektronische Adressenordnung, in: Stefan Andriopoulos et al. (Hg.), Die Adresse des Mediums, Köln (DuMont) 2001, 34-63 (41)

within the time-critical field, such as signal frequency and signal duration, sychronous or asynchronous clocking, and the decision on serial or parallel data transfer.

McLuhan at the borderline of digital computing

- McLuhan's emphatisis on electricity hampered him to conceive the computer as an algorithic device (aka Turing machine); alphanumeric processuality by-passing linear, analytic, visually based acquisition of information privileged by the alphabetic order, resulting in the "Euklidic control system"

- required three thousand years to unbound a kind of power which is the opposite of the alphabetically elementary "Euclidic centralism" - electricity with its acoustic qualities = Bruce Powers im Gespräch mit McLuhan, in: Marshall McLuhan / Bruce R. Powers, The Global Village. Der Weg der Mediengesellschaft in das 21. Jahrhundert, Paderborn (Junfermann) 1995, Kapitel "Von Engeln zu Robotern: Vom euklidischen Raum zum einsteinschen Raum", 169-184 (178); recursion of the alphabetic regime *within* the digital technologies

- Till A. Heilmann, Digitalität als Taktilität. McLuhan, der Computer und die Taste, in: Zeitschrift für Medienwissenschaft 3, 2/2010, 125-134 (128)

- operations of the symbolic machine called typewriter (discrete fingertips)

- chapter 11 of *Understanding Media* defines the nature of the number as "an extension and separation of our most intimate and interrelating acticity, our sense of touch" = McLuhan 1964: 107 - when fingers are used for discrete counting; counting in times of mechanized mathematics takes another dimension

- finishes McLuhan's Understanding Media with a chapter on "automatization"; Jens Schröter, Von Heiß/Kalt zu Analog/Digital. Die Automation als Grenze von McLuhans Medienanthropologie, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (Hg.), McLuhan neu lesen. Kritische Analysen zu Medien und Kultur im 21. Jahrhundert, Bielefeld (transcript) 2008, 304-320

- refers McLuhan, with his servomechanistic concept of man-machine symbiosis, heavily to the cybernetic epistemology of his days, but significantly blinds out its mathematical foundation on which Norbert Wiener always insisted - a mathematization which ultimately replaced McLuhan's vision of a synchronous, instant and resonant "acoustic space" by digital calculation

- McLuhan's media theory not updated in a linear way (as understood in history of technology or in signal processing: linear signal transfer between input and output), but rather as a toolbox, opening an awareness for media-induced phenomena acting upon humans. In an uncanny way, McLuhan transforms from a historicised media theorist into an up-to-date model exactly when reading him in his posthumous work, that is: almost alive. This inbetween-time (almost alive, nevertheless dead) is part of the argument already. All of a sudden, McLuhan seems a little bit less dead, when reading his identification of computing media as a machine whose essential message is rooted in its

delicate time mangement. Under this aspect, the computer as the dominant medium of today can not only be understood better, but turns out to be a chrono-poet itself, thus actively reshaping current culture on the basic level (or *a priori*) which George Kubler once described in his *Shape opf Time*. "Jeremy Rifkin shows that, thanks to the computer, visual centralized time is as obsolte as visual space. The Central Prcessing Unit orchestrates a ballet of operations in simultaneous times, chronology in counterpoint" = Marshall McLuhan / Eric McLuhan 1988: 53. This is an understanding of *mousiké* in its ancient Greek sense. Here, McLuhan comes close to what has recently been termed the "algorhythmic" (Shintaro Miyazaki)[542] - carrying his notion of "acoustic space" into the digital kernel

- computer not just time-based as performing arts and technical media before, but becomes itself chrono-poetical. A distinguishing feature of the computer is "its temporal creativity" = Marshall McLuhan / Eric McLuhan 1988: 53. Refering to David Bolter's *Turing's Man*[543], McLuhan points out "that while clocks are all set to the same exacting sequence, duration, and rhythm, the computer is free to manipulate all three of these temporal demensions by merely changing the program" <ibid.> - which is true especially for the von Neumann architecture of computing, a concrete embodiment of the algorithms - which is being-in-the-world, and thus: in time.

- Ivan Sutherland, head of the Asynchronous Research Center at Portland State University, points at the still clock-like mechanistic concept of distributing time within a computer (clocking). The asynchronous, on the contrary, allows every modular process to finish at its own pace; concept of data flow computing

- "Bolter argues that time is a resource for the compute just as coal is the resource for the steam engine" = Marshall McLuhan / Eric McLuhan 1988: 53 - an oblique metaphor: Would it be rather temporal information (neither matter nor energy)? The difference between clocks and computers, McLuhan underlines, is that "an ordinary clock produces only a series of identical seconds, minutes and hours, a computer transforms seconds or microseconds or nanoseconds into information" = Bolter 1984: 102 f.; McLuhan continues: "With this new timepiece, time is no longer a single fixed reference point that exists external to events. Time is now 'information' and is choreographed directly into the programs by the central processor" = Marshall McLuhan / Eric McLuhan 1988: 53; this "choreography" is media theatre in its dramtic, time-operative sense. "With computers we enter the age of 'multiple times'. Every program has its own sequences, durations, ryhthms, its own unique time" = Marshall McLuhan / Eric McLuhan 1988: 53, referring to David Bolter

- "While the clock establishes the notion of artificial time segments - hours, minutes, and seconds - it remained tied to the circadian rhythm. The clock dial is an analogue of the solar day, an acknowledgement that we perceive time revolving in a circle, corresponding to the rotation of the earth. In contrast, computer time is independent of nature: it creates its own context" = Marshall

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542 Shintaro Miyazaki, Das Algo*rhythmische*. Microsounds an der Schwelle zwischen Klang und Rhythmus, in: Axel Volmar (ed), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009, 383-396

543 David Bolter, Turing´s Man. Western Culture in the Computer Age, Chapel Hill (The University of North Carolina Press) 1984, 38f

McLuhan / Eric McLuhan 1988: 53. Genuine media time is *Eigenzeit*: "In acoustic space, every thin or event creates its won space, and time" = Marshall McLuhan / Eric McLuhan ibid. "The computer imprints a unique temporality into every program" = Marshall McLuhan / Eric McLuhan 1988: 53 - all the difference between an alorithms written with pencil on paper (like a musical score) and its implementation as a running program (like a musical performance). The message of the computer as medium is this tempo-reality

- McLuhan quoting Daniel Bell, *The Clock Watchers*, 55: "The electronic timer provides the measure by which the processor ticks its way through its calculations, ensuring <...> that one step is finished before the next is begun. The instructions themselves may require varying amounts of time ... This variation must be taken into account by the sequencing mechanism, which decides how many pulses of time to allot to each instruction" = Bell, as quoted in: Marshall McLuhan / Eric McLuhan 1988: 53; timing mechanism within the computer brings it close to rhythms (in the Aristoxenean sense who coined the term *chronoi* for measuring the temporal duration in music, dance and prosodic speech)

Short-cutting the channel: Diagram and topology instead of "mobility"

- tracing tempor(e)alities in the age of media mobility: mobility associated with linear ("analog") migrations and non-linear ("digital") dislocations in topological space and time; within the *temporal* and diagrammatic dimensions of mobility in media-based communication the despotic signifier "time" itself implodes, resulting in the necessity for alternative descriptions of the dynamics within the chrono-poietical field; the plausibility of "mobility" for analysing the current condition might turn out to be an antiquated remnant of modernism which blinds the insight into the topologies, diagrams and graphs of networked (chrono-)spheres.

- "serial" time - known from television as program format - is part of the geometrization (mathematization) of time (as opposed to entropic "natural" time).

- term "mobility" lags behind; left-over from discourse of modernity (its transport systems); in "digital" present times, rather techno-mathematical topologies ("Internet traffic") and heterochronotopies

- radically new, mathematic forms of trans-temporality

- real-time computing (*aka* reactive computing) hardware and software systems which are, at the same time, subject to constraints in bitstream transfer, such as operational deadlines from event to system response. By contrast, a *non-real-time system* is one for which there is no deadline, even if fast response or high performance is desired or preferred. "A real time system may be one where its application can be considered (within context) to be mission critical" = http://en.wikipedia.org/wiki/Real-time_computing

- term *real-time* derives from its use in early simulation. While current usage implies that a computation that is "fast enough" is real-time, originally it

referred to a simulation that proceeded at a rate that matched that of the real process it was simulating. Analog computers often capable of simulating much *faster* than real-time; as critical as a slow simulation if not recognized and accounted for

- techno-epistemological turn: digitizing communication channels results in transforming the *time* of transmission into numbers

Tempor(e)alities of archival and technical media as a challenge to cultural and historical time

- technological media not just an escalation in cultural techniques, but develop self-referential, auto-poetic tempor(e)alities which alter or irritate the established phenomenological categories of "inner" time perception and cultural memory. Such new chrono-poetic figures require a close reading of actual technical operations within time-critial and time-based media (their tempo-realities), while challenging the notion of traditional philosophy of time in favor of genuine media-temporality; Bill Viola, The Sound of one-line Scanning; John von Neumann, Report on the EDVAc, 1945; M. Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008 (special emphasis on the hard disc / computer storage)

Re:play. The lack of a sense of ending in technological media

- with photography, the unique temporal moment / (expusure-extended) "now" becoming reproducable (Roland Barthes) - extended to life-as-movement by kinematography

- "Zeit" in German a noun, suggesting substantiality; in English, though, there is as well the verb *to time*, *timing*" - and only Heidegger dared to make use of the word "zeitigen". The same structure happens for "end" ("Ende"), leading to *ending* - a temporalization of "time" and "end" themselves

The "sense of ending"

- "historical memory" privileging narrative form of representation; past / storage may as well be computed (between *conter* and *raconter*, in French) - actually closer to the archive, *histoire serielle* as proclaimed by the French historians around the École des Annales[544]; operating with variables in a process of truly mathematical analysis, algorithmical procedures

- storage time "empty" form, not dynamically unfolding, but invariant *stasis*[545]

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544 See François Furet, Qunatitative History, in: xxx
545 Götz Großklaus, Medien-Zeit, Medien-Raum: zum Wandel der raumzeitlichen Wahrnhemung in der Moderne, Frankfurt/M. (Suhrkamp) 1995, 47

- no *Halteproblem*: "Music always knows the end", Ernst Bloch describes the narrative dramaturgy of musical composition[546]; process-oriented analysis of musical dynamics in occidental musical art reveals that is has been mostly directed towards an aim towards it unfolds progressively

- with technomathematical electronic media, non-linear time becoming the dominant temporal figure; in 20th century, the dominant pieces of composition do not causally unfold any more, neither do they end in a harmonic, conflict-resolving *finale* = Hans-Ulrich Fuss, Musik als Zeitverlauf. Prozeßorientierte Analyseverfahren in der amerikanischen Musiktheorie, in: Zeitschrift der Gesellschaft für Musiktheorie 2/3 (2005); here quoted from the *online* version http://www.gmth.de/zeitschrift/artikel/205.aspx (accessed July 2009); equivalent to media-technological *Eigenzeit*

Gaming time

- with hypertextual media (computer games, and the World Wide Web), non-temporal modes of beginning and end become: hypertime; point and moment to step almost arbitrary[547]

- expressed in terms of mathematical theory of graphs, an adventure-computer game is everything which is defined by a beginning and an ending (almost „Homeric narrating", according to Erich Auerbach): everything which happens between point *a* and point *b* – *binary space partitioning*

- very act of observation (Spencer-Brown's "draw a distiction") requiring a temporal act; the switching of digital binary (which Wiener coined "time of non-reality"; in theory, this micro-temporal inbetween literally does not count)

- "A memory function remembers the same response to the same signal: a counting function counts it different each time" = George Spencer Brown, Laws of Form, xxx, 65; non-narrative time in action, replacing *raconter* (in French) by *conter*, disrupturing narrative (German "Er/zählung"). For the first time, in the so-called digital age historiography does not take place on the symbolical level of the phonetic alphabet exclusively, but on the level of electronically embodied alpha-numerics. In binary form the year 2000, f. e., appears as numerical string „11111010000", reminding us not to be seduces by narrative suggestion, but to calculate in discrete states, with the consequence not to tell events intransitively but to count them transitively, quantizing data. The media theorist Lev Manovich (in a chapter of his book *The Language of New Media*) calls this the aestheitcs of data banks, corresponding with a data-archaeological information ascetitics. Beginning and end, in computing media, are not structured by dramatical structures any more, but by the (equally complex) logic of *count down*.

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546 Here quoted after: Klaus Peter Richter, Zeitfenster des Augenblicks, in: Frankfurter Allgemeine Zeitung No. 128 (4th June 2003, N3)
547 See Stefan Heidenreich, Bilderströme. Lineare und nichtlineare Relationen zwischen Bildern, in: Kunstforum International Bd. 155 (2001), 243- 248

The temporal defect of Fourier Analysis

- Fourier Analysis ideally supposing infinitely extended sine waves as its components with no definite origin or ending, not decaying and thus theoretically timeless. But with no beginning and no end, this mathematical model misses the essential feature of "wordliness" which in Heideggerean terms is being-to-death; frequency information which is the result of a Fourier transform mathematically precise but on the expense of tempor(e)al precision. According to Charles Babbage's *Ninth Bridgewater Treatise*, reverberative traces of any present action continue propagating almost infinitely until entropic equi-distribution is being achieved; the *meta*physics of implicitely *sonic* wave forms (be it acoustic utterances, or water wave propulsions, or earth quakes) is "timeless" in the epistemologic sense of Fourier Analysis. This ontological defect has been remarked by Denis Gabor who developed his model of "acoustical quanta" instead; the temporal defect is nowadays being coped with by the development of a "time-windowed" sectional analysis of a signal event (Wavelets). Gabor's electro-acoustic "grains"[548] quantized the time domain itself.

- chrono-technical defect of Fourier Analysis and its algorithmic embodiment as Fast Fourier Transform evokes an alternative modelling of the physical carriers of information transmission ("tradition") that is invariant toward the erasures of entropic, "historical" time. There is temperature even in the replacement of traditional history of technology by different models of media-temporalities: a short-circuiting between past and present that the mathematical principles of such techno-logics enable by providing an operational link. Whenever we listen to sound from machines which has been previously encoded by FFT, we also share literally *a bit* of that past world "that is actually not past but non-linearly 'here.' This could be seen as a sort of a re-presencing of the past" = Jussi Parikka, introduction to part III *Microtemporal Media*, in: W. E., Digital Memory and the Archive, edited and with an introduction by Jussi Parikka, Minneapolis / London (University of Minnesota Press) 2013, 145, referring to Vivian Sobchak, Afterword: Media Archaeology and Re-presencing the Past, in: Media Archaeology: Approaches, Applications, and Implications (Berkeley: University of California Press, 2011), 323–33

Temperature in technological terms: data-entropy, energy, information

- "Die thermodynamische [...] Theorie der Sprache beginnt im Zustand des Rauschens."[549]

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548 Denis Gabor, Acoustical Quanta and the Theory of Hearing, in: Nature Nr. 4044, 159 (May 1947), 591-594
549 Hans-Christian von Herrmann, Informationsästhetik, in: Barbara Büscher / same author / Christoph Hoffmann (eds.), Ästhetik als Programm. Max Bense: Daten und Streuungen, Berlin 2004 (= Kaleidoskopien. Medien - Wissen - Performance, vol. 5), 81

- "Even our natural languages are made up of discrete, finite elements so that one could argue that all descriptions of continuous processes must be representable in some form by a finite discrete sequence of finite elements."[550]

- a "cloudy" reading of art historical paintings: Rudolf Arnheim, Entropy and Art. An Essay on Disorder and Order, Berkeley / Los Angeles / London (University of California Press) 1971

- "The concept of information applies not to the individual messages (as the concept of meaning would), but rather to the situation as a whole."[551] By the very *minus* operator in Shannon's formula, the resulting entropy will always be positive but induced the mis-understanding term *neg-entropic*.

- Markov chain analysis "flat historicity"; probability of a chain of strings from a finite alphabet to turn up in a discrete sequence dependent on its immediate predecessor. In turn this has effect on time-critical, media-economic techno-mathematical communication engineering (Claude Shannon) - a kind of intelligence which machinically operates both within minds *embodied* in humans and *implemented* in machines. The real drama which unfolds within the technological transmission (channel) and processing is are rather time-logical than culturally contextual; for an analysis of what "actually happens" (Ranke) in that *epoché*, cultural semantics transforms into shere signal-to-noise ratio

- with thermodynamic "heat death" (Flammarion), the past is "forgotten"; there is even no more time itself

- thermodynamic indexicality of photography (and film) is rooted in both the heat moment (sudden exposure, light flash), and in "cold memory": in the freezing of the fixed image, preferably in icy conditions, for long time storage purposes

- any transformation of entropic states into improbable information negentropic. Maxwell's demon may be equipped with a torch.[552] This introduces a momentum of feed-back into the circle between entropy, information and negentropy. What once arose as a diagrammatic thought experiment (Maxwell's "demon") has been actually tested in the laboratory. "The sense of sight provides the means for controlling entropy without itself being subject to the entropic process. <...> no fluctuation such as radiation interferes with the visual field, and the light that strikes the demon´s eye does not share in the entropic properties of mechanical motion itself."[553]

- in physical science, entropy names the tendency of element distribution in closed systems to become less and less organized, providing time with its

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550 Pattee 1974: 130

551 Warren Weaver, in: Claude E. Shannon / same author, The Mathematical Theory of Communication (1948/1949), Urbana / Chicago (University of Illinois Press) 1998, 9

552 See L. Brillouin, Maxwell's Demon Cannot Operate. Information and Entropy, in: Journal of Applied Physics, vol. 22, no. 3 / 1951, 334-337

553 Thomas Richards, The Imperial Archive, chap. "Archive and Entropy", 82

"arrow"[554] in accordance with the Second Law of Themodynamics. On the contrary, the informational state is based on Maxwell's" negentropic" demon: intelligent selection (equalling archival "Kassation", *triage*), thereby increasing the "temperature" of two separated thermic systems, resulting from an observational decision, opening / closing a "door" (be it an electromagnetic relay or an electronic flipflop) with the measuring unit *bit*

- "The entropy is a statistical parameter which measures <...> how much information is produced on the average for each letter of a text in the language. If the language is translated into binary digits (0 or 1) in the most efficient way, the entropy H is the average number of binary digits required per letter of the original language."[555]

- after centuries of philosophical speculation about the nature of time, entropy as defined by Rudolf Clausius and William Thompson in 19th century gave time its physical direction ("arrow") at all. A physical, energetic process is subject to the second law of thermodynamics which justifies the concept of a linear time direction. The same term "entropy", in communication engineering of discrete signal sequences, de-couples the term from the temporal regime, transforming it rather into Markov and ergodic processes

- Shannon-entropy; statistical mechanics provided the measure of information, choice and uncertainty[556]

- in Newton's abstract, mathematical, time-reversible physical mechanics, a cinematographically captured planetary revolution remaining intact even when projected backwards, different from the only statistically predictible molecular movement of gazes, liquids and clouds

- software emulators in computer-based computer chip design measuring time in clock cycles, estimating energy consumption in joules, and give realistic estimates of code size in bytes. These affect the life of a battery, "and the size and expense of the computer's largest physical part: its memory" = Wikipedia, entry "Computer Architecture", accessed xxx

- Espen Aarseth identifying a "thermic" genre of computer-generated poetry beyond narrative: "ergodic" literature; Cayley's poetry generator *The Speaking Clock* is re-generative in terms of Bergons's critique of mathematized time[557]

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554 Claude E. Shannon / Warren Weaver, The Mathematical Theory of Communication [*1949], Urbana / Chicago / London (Univ. of Illinois Press) 2nd. ed. 1972, 12 (reference to Eddington)
555 C. E. Shannon, Prediction and Entropy of Printed English [*1950], in: 50-(50)
556 Jussi Parikka, What is Media Archaeology?, Cambridge / Cambridge, Mass. (Polity Press) 2012, 100
557 See Espen Aarseth, Aporia of Epiphany in Doom and The Speaking Clock. The Temporality of Ergodic Art, in: Marie-Laure Ryan (ed.), Cyberspace Textuality. Computer Technology and Literary Theory, Bloomington / Indianapolis 1999, 31-42

- "Kanalspeicher", in: Horst Völz, Information, entry for Stefan Höltgen (ed.), Handbuch Technik für Medienwissenschaft, TS December 2016, 38, fig. 57

- transmission *medium* in Shannon's diagram is replaced by the storage medium for a therein (at an arbitrary moment in time) embodied / coded (transducer) time-variant signal $f(t)$ as carrier of information resp. noise $f(x, y, z)$. The signal here is frozen, until it is (at an arbitrary moment in later time) decoded as $f(t + T_{speicher})$. The channel capacity is measured in bits/sec. (telegraphy); its reverse in storage is enduring bits

- in statistical sense, "noise" comes in with the predictability of information transfer. "Thermal" communication theory extends to the technologies of cultural tradition itself. In communication-theoretical terms, there is insecurity resulting from the signal-to-noise ratio in the transmission channel (Shannon entropy): to which degree is the received, decoded signal the originally intended one (in archaeology: corrupt inscriptions; in philology: spurious texts). While in hermeneutics such insecurity is there in principle, guaranteeing open interpretation for eternity, the cryptoanalytic pragmatics (resulting in the successful deciphering of Mycenean Linear B writing by Ventris) knows that it is undecibable which distortion is intended (cryptography) or physical channel noise. For a cryptoanalyst, a secrecy system is almost identical with a noise communication system[558]

- acoustic pitch nothing but a cognitive metaphor for frequencies, the tone itself a periodic time event; pitch the microtime equivalent of rhythm[559] - and thus calculable by discrete mathematics. Digitization means a radical transformation in the ontology of the sound record - from the physical signal to a matrix of its numerical values. Media culture turns from phonocentrism to mathematics

- negentropic persistence against thermodynamic time arrow owing its ahistoricity to its different form of registering: not by signals (such as a phonographic recording the physically real acoustic event), but by operative symbols (such as the musical score); with mathematical computing, sampling and quantizing of acoustic signals transforming the time signal into frequencies as analysis and as a condition for re-synthesis; media culture turning from phonocentrism to mathematics

- automated analysis providing access to vibrational events by identification of its micro-temporal structures, beats and rhythm. The real time components of such a software analyzes waveforms by Discrete Fourier Transformation which in reverse can be (re-)translated and re-mediated into culturally familiar categories of sonic time structures - the "cool" jazz (McLuhan) of media theory

- on thermodynamic level, monitoring temperature subtly interferes just like Maxwell's demon when observing molecules for informative choice: The

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558 See Siegert, Relais, 1993, 290

559 See Karlheinz Stockhausen, ... wie die Zeit vergeht ..., in: Die Reihe. Information über serielle Musik, no 3, Universal Edition, Vienna / Zürich / London (1957), 13–42

physicist - or electronic sensor -, when making an observation, "transforms negative entropy into information"[560]

- Norbert Wiener's definition of "information" in *Cybernetics* 1948; in principle, a "bit" as unit of information is a quantity abstracted from both its energetic or material implementation. But as insisted by Szilard, any measurement must be recorded, be it written on paper or tape, or stored in a computer memory. "Information is physical."[561] Landauer proved that measurements (for information) can be realized at zero entropy production; the energetic costs rather results from the erasure of measurement memory. "The dissipation required to save the second law and to prevent us from making molecules in thermal quilibrium do work comes not from information transfer to the meter or control apparatus but from the subsequent resetting of that apparatus"; therefore Landauer proposes *reversible computation.*[562]]

- for heating of private house supplied with sun energy-generated electricity, VARTA in 2012 offering a Lithium-Ione battery as buffer memory in exchangable modules, which allows for a modular use of current, combined with "intelligent" measuring of energy usage and distribution for the most profitable moments of currency price, plus intelligent switches / smart grids); "information" of currency itself, not only simply driving computers any more, but itself object of computing

- emphatic geological and macro-climactic "deep time" turning into "flat" temporealities once re-formulated in media-technological terms; research on climate change, for an extended time line the reconstruction of temperature in times past is essential, since immediate change (as being observed in the "presence window") is difficult to Fourier-analyse. Reliable recording of climate only began in the 1880. Just like with sound from pre-phonographic times, paleoclimatic evidence can not be measured directly; therefore indirect evidence by climate proxies stand in - physical remnants such as ice-cores and tree rings. With so-called "preudoproxies", such archeo-thermal research turns informational, applying algorithms to combine proxie records into a hermispheric temperature reconstruction; this method highly vulnerable to computational uncertainty, "output from a climate model is sampled at locations corresponding to the known proxy network, and the temperature record produced is compared to the (known) overall temperature of the model" = entry "Proxy (climate)", Wikipedia

- computational mathematics (predictive analytics) now dramatically able to simulate climate change induced by its own (data center) energy cost itself, techno-epistemologically already one step ahead. "A rapidly computing model [...] would be used in the verification of experimental work", Vladimir Zworykin

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560 L. Brillouin, Maxwell's Demon Cannot Operate. Information and Entropy, in: Journal of Applied Physics, vol. 22, no. 3 / 1951, 334-337 (337)
561 Rolf Landauer, as quoted in: Juan M. R. Parrondo / Jordan M. Horowitz / Takahiro Sagawa, Thermodynamics of information, in: Nature Physics vol. 11 (2015), 131-139 (131)
562 Rolf Landauer, Information is physical, in: Physics Today (May 1991), 23-29 (26). See Harvey S. Leff / Andrew F. Rex (eds.), Maxwell's Demon. Entropy, Information, Computing, Bristol (Adam Hilger) 1990

announced in his "Outline of Weather Proposal" for the Princeton RCA Laboratories in October 1945 (p. 6), to keep pace with physical phenomena such as the weather. Reappearing on the computer screen, mathematical analysis (such as fractals) become dynamically *anschaulich*

"Ubiquitous oscillations" *versus* transient phenomena: Signals of ending in electronics

- Henri Bergson's *Matter and Memory*: merging of past with present perceptions in the diagram of a geometrical cone which obviously has been inspired by phonographic recording and its re-enactment by the mechanic (later electro-magnetic) pick-up; superposition of the periodic waves generates a complex signal implying the temporal *aporia* of its Fourier analysis

- 1948 Dennis Gabor criticizes idealism of harmonic Fourier analysis; hypothetically endless and beginningless periodic waves miss the temporal (eventual) implementation of a sound happening in the world, key stroke at piano, transient string play - the moment when an idealized model becomes an event in the real, that is: temporalized world

The visual alphabet, clocks and numbers vs. electro-acoustic space

- auditory sense "particularly adapted to perceptual anticipation in the detection of time patterns and is often so used; <...> either intensity or rhythm rather than pitch have usually been the modulation employed" = J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry (ed.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 372-389 (386)

- privileged relation between the frequencies of oscillations within the human brain and auditory sound wave perception; See Christian Kaernbach, entry "Echogedächtnis", in: Nicolas Pethse / Jens Ruchatz (eds.), Gedächtnis und Erinnerung. Ein interdisziplinäres Lexikon, Reinbek (rowohlts enzyklopädie) 2001, 132f, referring to N. Cowan, On short and long auditory stores, in: Psychological Bulletin Nr. 96 (1984), 341-370

- "In the space-time world of electric technology, the older mechanical time begins to feel unacceptable"; linear perception replaced by synchronisation; different from the classical five modal human senses, enhanced by being coupled to technological agencies. "By electric tapes, synchronization of any number of different acts can be simultaneous. Thus the mechanical principle of analysis in series has come to an end" = McLuhan 1964: 152

- "shift from a predominantly linear to an acoustic base in communication structure. Lines are disintegrating all around us. The NBC 'Today' show has a one-handed clock that indicates minutes past the hour. Since the program is viewed simultaneously in different time zones, it makes sense to tell the audience, 'It's ten minutes past the hour'" = Schwartz 1974: 9

- "The function of a communicator is to achieve a state of resonance with the person receiving visual and auditory stimuli from television, radio, records, etc. Decoding symbolic forms such as <...> drums, lantern signals, or written words is no longer our most significant problem. They extract meaning from perception in a manner prescribed by the structure of the lanugage, code this meaning symblically, and store it in the brain. But the brain does not store everything in this way. Many of our experiences with electronic media are recorded and stored in the same way that they are perceived. Since they do not undergo a symbolic transformation, the original experience is more directly available to us then it is recalled. Also, since the experience is not stored in a symbolic form, it cannot be retrieved by symbolic cues. It must be evoked by a stimulus that is coded in the same ways as the stored information is coded" = Schwartz 1974: 24

- "This state / of communication is like an electric circuit that is always turned on. <...> Today, there is a nearly constant flow of information at all times" = Schwartz 1974: 23 f.

- "Electronic communication deals primarily with effects. The problem is that no 'grammar' for electronic media effects has been devised. <...>. The patterned auditory and visual information on television or radio is not 'content'. Content is a print term, subject to the truth-falsity issue <sc. Platon, *Phaidros*>. <...> As stimuli, electronically mediated communication cannot be analyzed in the same way as print 'content'" = Schwartz 1974: 19

- "The space between phoning from one room in a house to another room in the same house is equivalent to the space between a caller in New York talking to someone in London. In both instances, space has no effect on the flow of information. Similarly, time is no longer relevant when communication takes place at electronic speed" = Schwartz 1974: 23

- critique of the notion of the "audio-visual" as such; asymmetries between the auditive and the visual in signal processing (in sensory perception which means *aisthesis* - and in technical media which means media-archaeological operations) in its different temporal configurations and eventalities ("the temporal gap", both in its techno- and neurodynamical significance); synchronization between sensory and signalling pulse trains; neuroscientific vocablulary to describe the cognitive timing processes within the human brain resemble the description of technological tempor(e)alities = working assumption of cybernetic system theory

- "Today in the electric age we feel as free to invent nonlineal logics as we do to make non-Euclidian geometries. Even the assembly line, as the method of analytic sequence for mechanizing every kind of making and production, is nowadays yielding to new forms" = McLuhan 1964: 85 - which is the algorithmic (especially recursive functions) in computing; Assembly language

- separation of "figure" and "ground"[563]; with the electric image the ground returned - a stochastic ground; "information" content of a television image

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563 McLuhan / Powers 1995, "Das resonierende Intervall", 25-36 (25)

- Bill Viola, *Information*, USA 1973. Videotape, colour, sound, 30 min. = Fig. in: Wulf Herzogenrath et al. (eds.), TV-Kultur. Das Fernsehen in der Kunst seit 1879, Amsterdam / Dresden (Verl. d. Kunst) 1997, 293

- "A television system capable of sending 26 brightness levels sends in one second the information content of approximately 2400 pages of print", Claude Shannon 1948 as a casual comment on the technological options of electronic coding[564]

- Tony Schwartz, in *The Responsive Chord*: when humans watch TV, their eyes function like ears

- "Time and number are fundamental non-verbal aspects of cognition"[565], located in the brain area that cares about sequential ordering (the number form); around 1980, Meck and Church proposing that time and number are represented by the same representational currency

Asymmetries: rhythms for example

- technological terms borrowed for time-critical events within human brain; working memory "refers to the maintenance and manipulation of information for brief periods of time" = Purves et al. (ed.), Principles of Cognitive Neuroscience, 2008, 341; working memory as defined by Alan Baddeley during the 1970s; three capacity-limited *memory buffers* and a *control system*. Each memory buffer maintains a different kind of representation. The *phonological loop* holds phonological (sound-based) representations, the *visuospatial sketchpad* holds visuospatial representations, and the *episodic buffer*" - like the *register* in the CPU of digital computers - "contains integrated, multimodal representations. Each buffer interacts closely with different long-term memory representations: the phonological loop with language knowledge, the visuospatial with visual semantics, and the episodic buffer with episodic / xxx" = Purves et al. (ed.) 2008: 406; remarkably close to the stored-program (working memory) concept of computing in von-Neumann architecture

- "Film transmits visual information by projecting a series of still pictures in rapid succession" = Michel Chion 1994, 13. "Following each frame, the screen is black for a nearly equal lenth of time" <14>. "The brain 'sees' motion by registering the current still picture, recalling previous frames, and anticipating future frames that will complete the movements. This differs considerably from visual experience in everyday life, where the eye is bombarded with a continuous stream of information" <14>

Asymmetries between the auditive and the visual

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564 Exposé Axel Roch zum Symposium *Claude Shannon und die Medien*, Berlin (Museum für Kommunikation) 3. Juni 2010
565 Dale Purves (ed.), Principles of Cognitive Neuroscience, Sunderland, MA (Sinauer), 4th ed. 2008, 51

- filmic genre of "still movies": long shots with quasi-photographic endurance. One can cut out a single frame in a film, copy it and produce a long (seemingly) immobile sequence (in fact, the medium - be it mechanically the cinematograph, be it electronically the video monitor - moves constantly), but the accompanying audio track, cut out of one frame, is a sample in its technical sense which - being reproduced, would rather result in a single impulse. An image (f. e. a portrait) can be visually frozen in the "photo film", but not a spoken word

- ear specialized on micro-temporal processes; different capacities in the *temporal* processing and differentiation. Two auditive stimuli with a difference down to two until five milliseconds can be differentiated, while visual perception needs at least 20 to 30 ms for distinguishing two successive stimuli = Mirjam Schlemmer, Audiovisuelle Wahrnehmung. Die Kongruenz und Ergänzungssituation von Auge und Ohr bei zeitlicher und räumlicher Wahrnehmung, in: de la Motte-Haber / Rötter (Hg.) 2005: 173-184 (173); cinematographic effect; alphanumeric binary data processing indifferent to the difference of the senses which on the interfaces returns only on the level of formats

- Lee DeForest, The Phonofilm, in: Transactions of the Society of Motion Picture Engineers 16 (1923), 61-75

- film camera fixes the image frames on a photochemical basis, while sound or speech is being recorded by application of the cathode ray tube which "writes" the signal on the carrier (on the basis of Vogt / Engl / Masolle 1921 proposal; achieved by Breusing-Hartel 1930); Manfred von Ardenne, Die Kathodenstrahlröhre und ihre Anwendung in der Schwachstromtechnik, Berlin (Julius Springer) 1933, 343. The audio-visual juncture breaks apart into the physical and the electronic; electronic difference to the audio-visual integration approach. When in sound film, the photo cell is used for reading visual information into sound again, it is the cold eye itself which transforms this without reference to any auditory or visual meaning, just operating on the principles of electro-magnetic induction

- Emanuel Goldmann's *Statistical Machine* on the basis of the photocell decoding of medatadata attached to mircofilmed records; see xxx Buckland

- Cornelius Borck, Blindness, Seeing, and Envisioning Prosthesis: The Optophone between Science, Technology, and Art, in: Dieter Daniels / Barbara U. Schmidt (Hg.), Artists as Inventors. Inventors as Artists, Ostfildern (Hatje Cantz) 2008

- film maker Oskar Fischinger in the early 1930s inscribing geometric patterns on the sound track of the cinematic celluloid which is the cold media-archaeological gaze on sound. While artists in the 1930s used this device for artistic sound synthesis (notably Lászlo Moholy-Nagy declared *Optofonetik* as the media art of the "Optisch-Kinetischen" and the "Akustisch-Musikalischen"[566]),*vice versa* the cathode ray tube has been used for visualizing

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566 See Jan Thoben, entry "Technische Klang-Bild-Transformation", chap. 4: "Gezeichnete Klänge - Das neue Verhältnis zum Ton"

sound; these media components themselves remain indifferent to cultural use = Thoben, entry "Technische Klang-Bild-Transformation"; photocell itself techically allows for actual transformation of image into sound: no synaesthesia, but signal transformation, not sensual, but electrophysical transducing

- basic asymmetry between the auditive and the visual in its different temporalities; Hermann von Helmholtz, by means of specially developed hight-sensitive chronometrical measuring media, calculating the temporal delay within nerves for incoming signals; the run-time (speed of progagation) of signals in the motoric nerves of a frog counts 24,4 meter/sec. - at the edge of a synchronization problem within humans, when technical audio-visual synchronicity might rather lead to irritation than to pleasure since because of its different physical signal run-times in real nature rather falls apart[567]; a lightning strike is seen more immediate than the accompanying thunder is heard / auditive short wave radio advancement of registering lightning

- protentional sound track on film reels; "Phase Alternating Line" (PAL) in colour television (version Bruch)

- Helmholtz: just because the nerve lines are so short humans mostly do not remark the signal transfer delay and thus get the feeling of being always one step behind the present at all[568]

- "According to Helmholtz´ experiments with human nervous reactions a tenth of a second signifies <...> the threshold separating [Humanities from the Sciences or] experience from measurement. <...> But since operating below the differential thresholds of sensual physiology counts to the possibility conditions of technical media – of film i. e. – the historical apriori of the Humanities is at the same time the physiological apriori or technical media. [The empire of media are the blind spot of the Humanities.] Unaccessible to experience and thereby to understanding in history is, [according to Dilthey,] the real or what only media can register or what only exists in writing but not in narration: the „noise of the battles <...>"[569]

A critique of the term and the notion of the "audiovisual"

- Platonic cave metaphor mostly remembered for its pre-cinematic *distpositif*;

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567 See Uwe Sander, Die "fehlende Halbsekunde", in: Handbuch Medienpädagogik, xxx (Springer) 2008, 290-293 (292)
568 Hermann von Helmholtz, Ueber die Methoden, kleinste Zeittheile zu messen, und ihre Anwendung für physiologische Zwecke, in: Königsberger Naturwissenschaftliche Unterhaltungen 2 (1851), Nr. 2, 169-189 (189)
569 Bernhard Siegert, Life does not count. Technological conditions of the bifurcation between Sciences and Humanities around 1900 (especially Dilthey), typescript from lecture on summer academy of Rathenau Foundation for the History of Science, Berlin, July 1994; in German: Das Leben zählt nicht. Natur- und Geisteswissenschaften bei Dilthey aus mediengeschichtlicher Sicht, in: Medien. Dreizehn Vorträge zur Medienkultur, ed. Claus Pias, Weimar (VDG) 1999, 161-182

Plato's remark on the audio event: While the inhabitants of the cave can be betrayed by shadows which they take for the movements of real beings, the sound which enters the case from outside is reflected at the inner wall with echo delay; slow speed of sound (as compared to the proverbial speed of light) irritates the visually orientated perception; auditory perception connects to the real, the visual to the imaginary, with the human ears being the substitute for the missing time organ, being much more sensitive to subtle changes in frequency than the eyes are to movement as change

- signal delay manifested in the echo effect Aristotle as well (in *Peri Psyches*) identified the existence of an "inbetween" (to *metyxy*), pre-theoretical term for "media" (as channel, defined by Shannons "Mathematical Theory of Communication")

"Live" is not *live*

- in audio perception in humans, mechanical vibration of signal trains translated into neuro-electric impulses which are synthesized in the brain; visual perception = parallel processing of light waves translated in electro-chemical transmitters

- chapter "Ton versus Bild", in: Christian Doelker, Kulturtechnik Fernsehen. Analyse eines Mediums, Stuttgart (Klett-Cotta) 1991, 185; video image recording born out of sound recording

- while electromagnetic sound recording realized in linear "writing" like the mechanical phonograph, image recording (vido) required a decisive modification of the medium, the rotating magnetic tape writing head in oblique, counter-directive way to cheat the temporal axis

Audiovision with Bill Viola

- time-critical message of sound within space; once the impression of space identified as a function of vibrations (which modern techniques of architectural acoustics pioneered by Wallace Sabine around 1900 perform by impulse-response-measuring), its conception becoming dynamic - starting with Jean-Baptiste Joseph Fourier who declared this in his 1822 *Thérorie analytique de la chaleur*. Temporal reverberations (Fourier uses, in his introduction, a term well acquainted from musicology: "resonance") replace rigid geometrical proportions; such vibrations themselves can be translated into a "geometrical" order of a second degree: frequencies, that is: mathematizable quantities (*spectra*); space becomes temporalized, phenomenogically noticable by the physical nature of refraction - "the beding of soundwaves due to a change in speed as they pass through different media" <Viola 1990: 41> -, of diffraction - "sound turning a corner, when the edge of a barrier generates a new series of waves" <ebd., 42> -, and by reflection - the rebounding of sound waves off a surface. "With multiple surfaces this becomes an echo, and it is then possible to hear one's own voice, possibily multiple in times, as it existed at a previous point in time. One can sing with one's self" <ibid., 42>; change in sound propagation takes place due to diffraction - "sound turning a corner, when the

edge of a barrier generates a new series of waves" <ebd., 42> -, and by reflection - the rebounding of sound waves off a surface. "With multiple surfaces this becomes an echo, and it is then possible to hear one's own voice, possibily multiple in times, as it existed at a previous point in time" <ibid., 42>

- propagation of acoustic waves requiring a runtime which can even be noticed by the human binaural perception; run time of acoustic signals can be measured by autocorrelation: folding a delayed signal onto its original = Gottfried Ehrenstrasser, Stochastische Signale und ihre Anwendung, Heidelberg (Hüthig) 1974, 90 f.

- "There is something of the immortal in an echo <...>; we can easily imagine an ultimate state of reverberation - a space where everything that has ever happened continues to exist - the end of time" = Viola 1990: 42; orig.: The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (Hg.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54. First published, in shorter form, in the catalogue for the National Video Festival, Los Angeles (The American Film Institute) 1986

- the auditive (based on wave propagation) is *immanent* to the electronic image. It is a media-inherent logic which in the late 1920s led John Logie Bairds to store electromechanical television lines on gramophone, his *Phonovision* storage system. From television to sound: *Phonovision*

- Léon Scott's *Phonoautographe* kind of "natural stenography" (Jonathan Sterne[570]) indeed - a kind of writing which emancipated from the vocal alphabet to such a degree that by optical scanning it can now be reconstructed as sound information again (like the song "Au claire de la lune") - with the digital processing being the true non-human archaeologist of an auditory event in the past (*audiovision* not as aesthetic phenomenon, but as technomathematical synaesthesia). The original phonautographic curves along the rotating cylinder (the *kymograph*) register the "actual" (that is, temporally authentic) acoustic event, thus being closer to operative Fourier analysis of sound than to cultural articulation

- different from the cinematographic image, the electronic image close to sound by (time) nature

- visual sense when confronted with electronic images affects the internal "sense" of temporality (as being-in-time) which is otherwise rather located within the auditory sense of perception, different from the durability which is the message of visual configurations (co-existence of bodies in space, as expressed by Gotthold Ephraim Lessing in 1766 = *Laocoön*): An Essay on the Limits of Painting and Poetry, transl. E. A. McCormick, Indianapolis (Bobbs-Merrill) 1962, esp. chs 16, 20

- time-criticality of lip synchronization in films. A special application of spatio-temporal video warping is dubbing a video with another soundtrack: "The new soundtrack rarely matches the lip motion of the original video, and particularly

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570 Jonathan Sterne, A Machine to Hear for Them: On the Very Possibility of Sound´s Reproduction, in: Cultural Studies Bd. 15, Heft 2 (2001), 259-294 (267)

disturbing are cases when the mouth moves but no sound is heard [...]. The mouth motion can be accelerated or slowed down using an appropriate time flow"[571]

- acoustic temporality anticipating technical inventions: "If we sense that the description of sympathetic vibration ["resonance"] bears some resemblance to radio broadcast, it is no coincidence, the same principle is at work" = Viola 1990: 42, equiprimordially

Kinaesthetics of the electronic image (with Viola)[572]

- video image, with its divisions into lines and frames, "is a living dynamic energy field, a vibration appearing solid only because it exceeds our ability to discern such fine slices of time" <Viola 1990: 44>[573]

- "As much as the infinitesimal calculus that *pretends* to deal with motion and change by minute fragmentation, the film *does* so by making motion and change into a series of static shots. Print does likewise while pretending to deal with the whole mind in action. Yet film and the stream of consciousness alike seemed to provide a deeply desired release from the mechanical world of increasing standardization and uniformity" = McLuhan 1964: 295

- In 1911 Henri Bergson's *Creative Evolution* associates the thought process with the time-discrete form of the movie

- synthaesthetic transfer (audio-visual metonymy) takes place, when the "video as a virtual image" is being discovered in its "vibrational acoustic character" <Viola 1990: 44>; media-archaeologically true: "Technologically, video has evolved out of sound (the electromagnetic) and its close association with cinema is misledaing since film and its grandparent, the photographic process, are members of a completely different branch of the genealogical tree (the mechanical / chemical)" <ibid.>

- theorem of the electronic image as quasi-phonographic one-line-scanning (with the notable pre-digital difference of the interrupted line jump)

- "The video camera, as an electronic transducer of physical energy <light> into electrical impulses, bears a closer original relation to the microphone than to the film camera" <Viola ibid.> - closer to the electro-chemical transduction within human eyes and ears when communicated to the brain

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571 Alex Rav-Acha et al., Evolving Time Fronts: Spatio-Temporal Video Warping, http://www.vision.huji.ac.il/videowarping, chap. 4 "Spatially Varying Time Flow"
572 Bill Viola, Der Klang der Ein-Zeilen-Abtastung, in: Theaterschrift 4: The Inner Side of Silence, Brüssel (September 1993), 16-54; orig.: The Sound of One Line Scanning, in: Dan Lander / Micah Lexier (Hg.), Sound by Artists, Toronto / Banff (Art Metropole & Walter Phillips Gallery), 1990, 39-54. First published, in shorter form, in the catalogue for the National Video Festival, Los Angeles (The American Film Institute) 1986
573 See as well Maurizio Lazzarato, Video Philosophie, Berlin (b_books) 200x

- frequency-based technologies *resonate* with the human perceptual mode in a privileged way; on the side of media-theoretical analysis (and consequently technological synthesizability) is matched mathematically by the Fourier analysis which applies to periodic signals of almost all kind (continuous and discontinuous)

- "Musicall speaking, the physics of a broadcast is a type of drone. The video image perpetually repeats itself without rest at the same set of frequencies" = Viola 1990: 46. "Western music builds things up" <ibid.>, synthetically. "It is additive: its base is silence <...>. Indian music <...> begins from sound. It is subtractive. All the notes and possible notes to be played are present before the meain musicians even start playing, stated by the presence and countin of the tambura. A tambura is a drone instrument, usually of four or five strings, that, due to the particular construction of its bridge, amplifies the overtone or harmoic series of the indivual notes in each tuned string. It is <...> continually present throughout" = ibid.

Media of audio-vision: Sound film and music video

- synchronicity between the sound camera and the film camera: this audiovisual harmony is rather counter-naturally (that is: technically) achieved, negentropically, a betrayal of *Gleichzeitigkeit* towards the human temporal perception in multimedia; two chrono-technologies at work within sound film: a) technically enforced synchronization and b) Timecode (since analog-hybrid video days), somewhat corresponding with the "internal clock" mechanism within the human brain and the multimodal sense data integration. What is at work here is *both* the analog (continuous) and the digital (quasi-numeric) regime

- What started with mechanic cutting of celluloid as time-order-manipulation *within* the narrative filmic frame (montage), with digital imagery led to complete non-linearity in adressing the content, *explosive time.*[574]

- "live" transmission of television is a betrayal of the temporal gap: a minimum delay even in ultra-speedy electro-magnetic waves which finds its limits at the speed of light; with sound this delay is more critical, since human sense would sense a temporal delay in acoustic waves which travel comparatively slow (330 m/sec.), creating an asymmetry for human senses between the transmission of electromagnetic and of mechanical waves

- what appears as technical failure, turns out to the condition for audio-visual perception within humans: Image and sound should not be exactly synchronous, but slightly delayed. Signals, not at the same time technically expressed, create the impression of synchronicity[575]

From silent movies to film sound

574See Michael Rubin, Nonlinear. A guide to digital film and video editing, 3rd ed. Gainesville 1995
575 See Christian Kassung / Olaf Kriseleit, Bild als Medium, xxx 2002

- hyphen both binding and separating the auditive and the visual appears in Michel Chion's Audio-vision. Sound on screen, New York (Columbia University Press) 1990

- due to different signal delay time (*delta-t*), audio track in sound films has to be installed *asynchronically* in relation to the visual frames - a differential time domain. What the sound at a moment of time articulates does not relate to the frame above, but to the next one = Gerhard Schumm, Diagonalmontage und Fotofilm, in: Gusztáv Hámos / Katja Pratschke / Thomas Tode (eds.), Viva Fotofilm. bewegt/unbewegt, Marburg (Schüren) 2010, 151-162 (157), referring to Hollis Framton's film *Nostalgia*, USA 1971

- clear separation (against "audiovisual media" term) between "audio" and "visual". The one is physical vibration, mechanical impulse, the other refers to the electomagnetic spectrum, a sense organ for "radio" in terms of radiation; ears and eyes are completely different data processors.

- expriments by Edison's engineer Dickson with coupling a phonograph with cinematograph: synchronization problems

- by definition, sound film a time-critical medium. With the introduction of the optical film soundtrack in the end 1920s, "the sound is photoelectrically recorded on a narrow track beside the visual images, and the fact that it is visible means that is can even be monitored and analysed. <...> Many of these systems used a principle derived from that of the siren, interrupting the light-beam by a rotating opaque disc in which holes or slits had been cut." <Davies 1994: 6; fig. 7>]

- most of photoelectric organs and organ-like intruments from the late 1920s and the 1930s were based on the mechanism of a rotating disc that interrupted the passage of a beam of light between its source and a photocell <...>, thus avoiding the wear and tear of direct contact with the surface of the recording

- (Video) synthesizers take over synaesthetics, with their time-base correctors.

acoustic signals are functions of one variable only: time[576], whereas images contain two further spatial variables.

- storage of sound linear (phonographic groove), like a graphic inscription of the time line, wherease cinematograpic movement requires discreet storage in single frames: punctual, "logical" time

- technical synchronisation of two sensorial channels; when sound and vision is simultaneously recorded (like in the Edison Kinetophon, 1913), re-play (projection) nevertheless needs mechanical coupling; thus synchronisation is forced upon as temporal violence

- sound film not simply an extension of the silent film, but a new media process = Salm 2010: 3

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576 See Friedrich Kittler, Optische Medien. Berliner Vorlesung 1999, Berlin (Merve) 2002, 276

- only with sound translated into modulated ligh can sonic articulation be inscibed on the movie carrier celluloid "within its own medium". Its media-archaeological condition is the electronic vacuum tube, a media-epistemologically completely different approach, first developed by Ernst Ruhmer (his Photographophon, 1901). The alternating current induced by the microphone is "rhythmically" inscribed as light information on the celluloid analogue to the varying sound amplitude. The key element is the selenium cell.

- as cinema, the auditive and the visual breaking apart both technologically and in human perception

- cultural prefiguration intervenes: In narrative video-clips the perception integrates audio-visual differences in other ways than for non-narrative video-clips <Schlemmer 2005: 183>; the affective reaction is different, like the "sonic" as different from the simple physical "acoustic" (Peter Wicke)

- synchronous sound turns mechanical cinema into an "art of time" = Jan Philip Müller, Synchronisation als Ton-Bild-Verhältnis, chap. 5 "Lichtton: An art of time", under: http://beta.see-this-sound.at/kompendium (access July 2010), referring to xxx Chion, L'Audio-vision (1994), 16

... with Chion

- critical difference between the physiological processing of images and sound in its temporality: "Sound perception and visual perception have their own average pace by their very nature; basically, the ear analyzes, processes, and synthesizes faster than the eye."

- Chion's argument re-invents Lessing's basic distinction he makes in his treatise *Laocoon* between the semiotics of the visual arts as compared to the literary arts: "The eye perceives more slowly because it has more to do all at once; it must explore in space as well as follow along in time. The ear isolates a detail of its auditory field and it follows this point or line in time. "So, overall, in a first contact with an audiovisual message, the eye is more spatially adept, and the ear more temporally adept" = Michel Chion, Audio-Vision. Sound on Screen [FO L'Audio-Vision, Paris (Nathan) 1990], ed. and transl. by Claudia Gorbman, foreword Walter Murch, New York / Chicester (Columbia UP) 1994, 11

- slowness of human visual perception, the "after-image" in retinal perception, as physiological condition of the possibility of perceiving movement where technically there is a fast series of interrupted images in the film projector

- time-critical acoustics; "a paradox: we don't hear sounds, in the sense of recognizing them, until shortly after we have perceived them. [...] Hearing - namely the synthesized apprehension of a small fragment of the auditory event, consigned to memory - will follow the event very closely, it will not be totally simultaneous with it" = Chion 1994: 13

- "By visual microrhythms I mean rapid movements on the image's surface caused by things such as curls of smoke, rain, snowflakes, undulations of the

rippled surface of a lake, dunes, and so forth — even the swarming movement of photographic grain itself, when visible. These phenomena create rapid and fluid rhythmic values, instilling a vibrating, trembling temporality in the image itself. <...> It is as if this technique affirms a kind of time proper to sound cinema as a recording of the microstructure of the present" = Chion 1994: 16

An electronic device for wilful (technological) synesthesia: the Optophone

- core element of early television is the photosensitive cell which translates light energy into electric current by the photovoltaic effect

- Dadaist Raoul Hausmann's *Optophon*; made use of the *Photographophon* as developed by the engineer Ernst Ruhmer 1901 at the Technischen Hochschule in Berlin as a procedure for storing speech signals by light traces (and reverse).

- Hausmann (for signals) anticipating present practices in the data sonification

- Lee DeForest, inventor of the first "electronic", that is: manipulable vacuum tube (triode) and the "Audion" radio, recalls Ernst Ruhmer's 1906/07 experiments as attempt to photograph sound vibration by means of the *speaking arc*: "Strong telephonic currents from a powerful microphone were superimposed on the direct current across the arc, producing sufficient fluctuations in the arc light to permit a crude photographic record upon a cinematograph film which was driven at a very high speed."[577]

- in a non-linear turn the Optophone did not lead to sound film but to digital computing. This media event is to be described a-historiographically: not "from analog audiovisual aesthetics (and *aisthesis*) to digital calculation", but rather: an abstraction. "The optophone was a <...> apparatus which employed the photosensitivity of a selenium cell for converting light into sound".[578] The presentation of this apparatus led London's *Pall Mall Gazette* to comment that the new approach interfered with the natural order of the senses and lead to a fundamental irritation of the human perceptual order and separation of time and space on the level of delay time *(Laufzeit)* between sound and light itself: "An ingenious Birmingham scientist has turned the element of selenium to account by making light audible, and we are to be dazzled and deafened both at once. Sunlight makes a roaring sound, and lightening, presumably, anticipates its concomitant thunder. All we require now is to increase the anticipative process, and then day light will awaken us every morning a couple of minutes before it arrives" = June 24, 1912, as quoted in: Borck 2008

- E. E. Fournier d' Albe, The Moon-Element. An Introduction to the Wonders of Selenium, London 1924

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577 Lee deForest, The Phonofilm, in: Transact. of the Soc,. of Motion Picture Engineers Nr. 16 (1923, 61- (61)
578 Cornelius Borck, Blindness, Seeing, and Envisioning Prosthesis: The Optophone between Science, Technology, and Art, in: Dieter Daniels / Barbara U. Schmidt (Hg.), Artists as Inventors. Inventors as Artists, Ostfildern (Hatje Cantz) 2008, xxx-xxx (introduction)

- Marshall McLuhan discovering the Optophone as an epistemological device behind the aesthetics of James Joyce's *Finnegans Wake*, the replacement of the linear typographical regime by electronic acoustic space

The neurological basis for synesthesia and its electrophysiological detection

- difference is bio-technical: Differences of pressure in the air are being faster transformed (transduced) into elektrophysiological signals (and transferred to the auditive system in the brain) than the transformation of light in visual impulses happens. The photochemical process on the retina takes longer, as well as the spatial analysis of visual information = Mirjam Schlemmer, Audiovisuelle Wahrnehmung. Die Kongruenz und Ergänzungssituation von Auge und Ohr bei zeitlicher und räumlicher Wahrnehmung, in: de la Motte-Haber / Rötter (Hg.) 2005: 173-184 174

- media-archeological argument: It takes electrophysiological high-sensitive (vacuum-tube-amplified) measure instruments to detect such phenomena; alliance between the measuring media of brain activity and their essential performance, with both relying on electric events. Only with the advent of the vacuum tube amplifier it has been possible to detect smallest electric currents passing through nerves.

- neuroscientist Robert Galambos in the 1930s implanting microelectrodes within single fibers of animal nerve tissue to capture and record electrochemical nerve impulses going from the ear to the brain; here each nerve cell responds to a particula sound frequency of that frequency's absence. "The result was learning the code by which nerves send messages about sound."[579] The phrasing already implies a signal transmission model (in fact: a communication theory) of the auditory perception (the engineering model).

- with Claude Shannon, alliance between brain signal processing and communication media becomes even tighter, since Shannon switched communication engineering from analogue to digital transmission, with impulses representing the informational unit of a bit and allowing for the "ciphering of the real"[580]; coincides with the detection of pulse trains in human signal perception.

- Galambos' interpretation that the eye sends information to the brain in discrete packets tied to eye movement rather than continuous perception - a supposition articulated since Hermann von Helmholtz.

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579 Paraphrase of a comment by Steven A. Hillyard, University of California, San Diego, by Douglas Martin, Robert Galambos, Neuroscientist Who Showed How Bats Navigate, Dies at 96, in: The New York Times, July 18, 2010 (New York edition); *online* http://www.nytimes.com/2010/07/16/science/16galambos.html (accessed July 21, 2010)
580 "Verzifferung des Reellen": Friedrich Kittler, Optische Medien. Berliner Vorlesung 1999, Berlin (Merve) 2002, 320

- experiments with augmenting the visual impression of film by sound = Lee DeForest, The Phonofilm, in: Transactions of the Society of Motion Picture Engineers 16 (1923), 61-75

- neuroscience itself victim to *imaging sciences* / visualizing brain functions; alternatively: sonification of brain waves / neuron oscillations

Is there a specific sense of time?

- neuroscientific vocablulary to describe the cognitive timing processes within the human brain resembling the description of technological tempor(e)alities

- "The human sense of time operates over many different scales and involves a variety of neural systems. <...> It is not clear whether there is a central internal clock for interval timing"[581]; some models of interval timing imagine a kind of oscillating mechanism (clock) to be the pacemaker that emits pulses which flow into a neuronal accumulator; "accumulator values are transferred directly into reference memory or via working memory" = Purves et al. (eds.) 2008: 558

- to what degree theatre and drama studies helpful to analyze the operativity of digital media; time-based character of both theatre / drama and the von-Neumann-computer architecture which links both; transform this into experimental performances which (re-)translate the sublime data processing in machines (since unrecognizable for slow human senses) into three-dimensional, audio-visual space

"Richard Two Bodies"

- „On the one hand, the weakened body becomes a prosthetic to the media-net; and on the other the body electronic is data trash struggling to come alive again in recombinant form" = Arthur Kroker / Michael Weinstein, Data trash, New York 1994, 3

- semi-virtual staging of Act IV of Shakespeare´s drama *Richard II* in order to visualize the implicit theory of „the king´s two bodies" with real actors in inter-action with virtual bodies; rehearsal of the „mirror scene" in the studio of the Academy of Media Arts, Cologne, replacing the mirror by a camera which at the same time mirrors Richard´s face and allows for digitally manipulating this face in real time into an anamorphic image (morphing Richard)

Hatsune Miku "on stage"

- "vocaloid" as bodiless voice; real-time virtual actor on stage. Accompanied by an actual live band. Do human musicians, when coupled to a software performance, change from the "live" to the "real time" (digital) mode?

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581 Dale Purves, Principles of Cognitive Neuroscience, Sunderland, MA (Sinauer) 2008, 51

- If such a holographically animated vocaloid is rehearsed on setage in the real presence of a human audience, is such a re-embodied voice perceived in different ways than acousmatic voices from loudspeakers and earphones?

- presentation Hee Seng Kye, Music Research Center, Hanyang University, Koreahskye@hangyang.ac.kr "(Re)sounding the Virtual: Hearing the Voice of Hatsune Miku", conference *Sound Art Matters*, University of Aarhus, June 1-4, 2016; lecture Borbach "Sirenic voices", workshop Jerusalem; Steven Feld, "acoustemology"

Non-"museal", operative material media archaeology (MAF, Signal lab)

- material objects in the museum by their very presence resisting the passing of time; Roman inscriptions in the Vatican museum; still possible to decipher the letters inscribed in stone, whereas in media culture fast transmission is the most valuable quality, an almost immediate transfer of information; "live" aesthetics of transmission of live radio and live television is now called real time processing; telegraphy; virtue of the museum to undo long time distances, to transfer objects in a time channel of transmission (*alias* tradition, heritage); in re-enacting technological devices, the rather time-invariant techno-logical diagram shines through, against the historical context-dependence; "media tempor(e)alities"; cognitive dissonance: they are past but affect sense of present when in operation

- dilemma of curatorial practices employed in museums of technology; media technologies need to be displayed *in implementation* in order for them to be understood; difference between museum-displayed technologies and the operationalization of technical media in the Fundus; the work of a media archeologist more closely resembles that of an engineer than a historian

- museum appeal depends on the physical evidence, but residual smell of oil in old machines if not cleaned too much reminds of / traces former action

- entropy of the material / decay provides for evidence of one-directional time; physical law of thermo dynamics = a tendency from order to disorder, gives "time" a physical sense; during *Delta-t* of an enduring magnetic video tape, "time" at work in the physical sense; digital copy with no decay; stochatically defined "information" (mean predictability of bit sequences) can be preserved almost without loss; material entropy (except from "quantizing errors" in the digital copying process) not at work; creates a different sense of time; gap between the culture which is dominated by the experience of entropy in tradition, and digital culture of controlled compression (rather than lossless) transfer

- technological media elements which at first glance look outdated but become retro-avantgarde once being deciphered with media-archaeological eyes and minds - such as a telegraphy apparatus which turns out "digital" *avant la lettre*, by-passing the age of so-called "analog" signal processing media like electric telephone; resist the melancholic impulse which is associated with so-called "dead media"; electric telegraph operates with discrete signal transmission: a

code which after an age of AM media (such as radio) returned in unexpected ways

- non-functional machines and electronic elements in the MAF challenge for media-didactic analysis; taking machinic elements apart in order to try to reanimate their function a way of media analysis in the strict sense: not restricted to textual interpretation but to diagramatic reading of circuit plans and material hermeneutics (media-archaeological philology). If it comes to source code in the case of ancient computers, take the name of the machine-orientated programing language ASSEMBLY literally and dis- and re-assemble it. The media-ontological definition that a technical apparatus is in existence only when being operative requires at least the effort for re-accessing its material processes - even by simulation or digital emulation; repairing dysfunctional media-archeological artefacts: in most cases the re-animation of valuable technological antiquities (like an early TV set) can, for curatorial reasons, only happen a few times without ruining the original ingredients completely; repair once, repeat many times - by recording the singular event in sound and video; movies attached to the online presentation of the MAF a form of "operative" memory / argument in another, time-able medium than the physical collection

- memory regime of media culture both material and symbolic, both engineering and mathematics; two-faced meaning of *technology*: *techné* on the one hand (impressions of physical hardware) and *lógos* on the other (the logical and mathematical intelligence resulting in software)

- media archaeology with a mathematical cutting edge; archaeology (the science of *arché*) is not about media-historical origins, beginnings / inventions, but the archaic: principal functions / logic / circuit diagram; as well about the "square root" for real numbers, physical frictions; symbolic / real machines

- juxtapose artefacts from telephone technology (an electro-mechanical relay element, a variation of Strowger's Automatic Telephone Exchange or a Manual Telephone Switchboard) with devices from early electronic computing to demonstate how the hardware to perform discrete numerical operations - nowadays almost exclusively be associated with the digital computer - has been literally transfered from a voice communication technology - just like the vacuum tube which had been invented for amplification of week electric signals but was later "mis-used" in Flipflop circuits of early stored-program computers; hybrid cross-overs define "the mode of existence of technical object" (Gilbert Simondon)

- specifically media-induced ways of "re-presencing" the past: technological ways of re-generating and re-storing time signals; media-archaeological focus on the conditions under which the technological past can "have 'presence' in the present"[582]; escape the romantic orientation "via the insistence on a rigorous attention to matter and machines [...]"[583]

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582 Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333 (323)
583 Goddard 2014, 13

- analogue media archaeological artifacts requiring to work rather "in principle" (literally "archaeologically") to be studied; computational, that is: programmable media produce digitally coded signals

- study media hardware and their signals by opening them, measuring frequencies, sound outputs, voltages; such technologies unfold in their presence when not looked at as economical, techno-historical, or social (STS) gadgets but as signal processing media

- epistemic curiosity as "first trigger" for re-using old/dead/vintage hardware and software; one can not actually use an "old" medium "historically": from the moment it is turned on it is totally "historical present" (grammatical time different from "imperfect"), in presence. Even if you use your C64 with its old floppy drive and old games you are playing those games now and you are bringing it to function now; term "retro" a figure of time for the "short cut" between the past and the presence = Stefan Höltgen, interviewed by Jussi Parikka, August 29, 2016, *online* xxx

Cultural tradition / transmission in terms of communication theory

- conference "Kulturarvteknologier" or "The Technologies of cultural heritage" (from archives to museums and the machines they use to store, retrieve and update sources) = Eivind Røssaak

- well-recognized "globalization" of cultural values through web-based media splits "cultural value" into a) material and b) informational commodities. Cultural value has been "residential" in occidental tradition (the classicist museum / eternity value approach); with modernity, this has been mobilized / liquified. Coupled to electronics (a) and information theory (b) no more matter nor energy

- engineering definition of (tele-)communication counts for the mechanism of cultural tradition as well: "The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point."[584]

- *channel* in communication engineering is „the medium used to transmit the signal from transmitter to reveiver" = Shannon / Weaver 1963: 34, involving all kind of side-effects, all the unintended patterns and changes; its cultural equivalent is "tradition". Noise has been excluded as cultural value for long times; media-archaeology uncovers a *mémoire involontaire* of recordings from the past which was not intended for tradition - a noisy memory, unaccessable for alphabetic or other symbolic writing. This becomes most apparent in acoustic records themselves. Listening to ancient phonograms, there is always as well the scratching, the noise of the recording apparatus. True media archaeology starts here: The phonograph as media artefact does not only preserve the memory of cultural semantics but past *technical* knowledge as

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584 Shannon / Weaver, The Mathematical Theory of Communication (1949), 31

well, a kind of frozen media knowldege embodied in engineering and waiting to be un-revealed by media-archaeological consciousness.

- cultural heritage in times of communication media: model of techno-cultural "memetics" where cultural knowledge is transmitted by gene-like entities called "memes" which can be either an idea, belief or belief system, or pattern of behavior that spreads throughout a culture either vertically by cultural inheritance (as by parents to children) or horizontally by cultural acquisition (as by peers, information media, and entertainment media); a pervasive thought or thought pattern that replicates itself via cultural means; a parasitic code, a virus of the mind especially contagious to children and the impressionable the fundamental unit of information, analogous to the gene in emerging evolutionary theory of culture; memetics the study of memes; in blogspeak, an idea that is spread from blog to blog; an internet information generator, especially of random or contentless information = http://www.urbandictionary.com/define.php?term=meme

"Cultural value" and the sense of time

- Instead of traditional endurance, "changing values" is the the signature of modernity. The drama of modernity is the much-lamented dislocation of enduring values by permanent change - which, in terms of Henri Bergson, is the true nature of time. Bergson always insisted "there is no other thing in time than change itself"[585] - which is still an analog notion of continuous time. The opposite is true for the sense of time in digital culture which is structured by non-linear, hyper-temporal access to virtual worlds by discrete addressability (the nature of archival data administration).

- value parameter "historical tradition" or "cultural heritage" under attack, to be replaced by recording presence in real-time, respective re-presencing the memory at an instant, as in photography services like Instagram. While the traditionally rather immobile archive literally gets "in motion"[586], digital culture itself is based on radical temporalization in its most technical sense, since its operations take place in a time-critical window of the present, with the volatility in electric communication where storage media themselves become "dynamic" (RAM) which require refresh cycles

- "When engineers talk about a computer´s `memory´ they really don´t mean a computer´s memory, they refer to devices, or systems of devices, for recording electric signals which when needed for further manipulations can be layed back again. Hence, these devices are stores, or storage systems, with the characteristic of all stores, nameley, the conservation of quality of that which is storede at one time, and then is retrieved at a later time. The content of these stores is a record <...>. <...> `memory´ is a misleading metaphor for recording devices <...>. Of course, these systems do not store information, they store books, tapes, microfiche or other sorts of documents <...> which only if looked upon by a human mind may vield the desired information. <...> By confusing

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585 As recalled by P. Janet, L´Evolution de la Mémoire et de la Notion du Temps, Paris (Chahine) 1928, 28

586 See Eivind Rossaak, xxx

vehicles for potential information with *information*, one puts again the problem of cognition nicely into one´s blind spot of intellectual vision <...>."[587]

- GPS; "real time of ubiquity and instantaneity, <...> less physical than microphysical"[588]

- in a networked world, money moving from place to place as data, invisibly, across wires and satellites and as light impulses on fiberoptic cable. Money moves at the speed of light

- where relative value of currencies changes from moment to moment, exact time stamp of when the money moves is of paramount importance. The disappearance of time by instantaneity

- universally recognized temporal grid - the clock - allows transactions to occur in a common virtual space regardless of geography

- temporalization of value: cp. high-frequency trading at stock market (started with stock market ticker; Lit.: Alex Preda); "optonism", derivatives

- "frequency domain" of what is the "time domain" in telecommunicative signal transmission; its capitalist value: it can be measured; a depesche in the Indo-European Telegraph Co. line between London and Kalkutta (opened 1870) took between half and one hour and was exactly payed in Swiss Frank (the then international currency) for each telegram (87,5 Wwiss Franks per Depesche), with around 200 telegrams per day

- *streaming*. "Our candidate for replacing the desktop is called `Lifestreams´."[589] "Every time you use a creative work in a digital context, the technology is making a copy"[590]; there is no more entropic time inbetween original and copy. The singularity and endurance of the traditional work of art is being replaced by ephemerality and logical (rather than Benjamin's analog) reproduction as co-originary recreation. The material embodiment (which is still required) itself becomes transitory, a function of algorithmical computing.

Not yet memory? Intermediary storage, delay lines

- first British fully electronic computer, developed in 1949 and engineered by Wilkes, Wheeler and Gill, called EDSAC = Delay Storage Automatic Calculator

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587 Heinz von Förster, Thoughts and Notes on Cognition, in: Paul L. Garvin (ed.), Cognition: A Multiple View, New York / Washington (Spartan Books) 1970, 25-48 (29f)
588 Paul Virilio, L´écran du désert, zitiert nach: Laura Kurgan, You Are Here: Information Drift, in: assemblage 25 (1995, MIT), 15-43 (28)
589 David Gelernter, Machine Beauty. Elegance and the Heart of Technology, New York (Basic Books) 1997, 102
590 Lawrence Lessig, Remix. Making Art and Commerce Thrive in the Hybrid Economy, London (Bloomsbury Academic) 2008, 98

- new temporality of cultural value, its (algo-)rhythmization, becoming transparent in the inner life of computing and communication engineering: a delicate system of "sampling" presence and its mathematical processing which consists of ultra-short moments of intermediary storage (the "registers" in the Central Processing Unit of micro-processors) and volatile "dynamic" short-time storage (RAM chips), or by intermediary calculation (predictive algorithms) in massive data transfer (digital tele-communication)

Resisting acceleration: the *katechontic* function of archives and museums

- position of the museum as a beholder of cultural materiality against the backdrop of digital acceleration. How can a museum position itself within "the time-critical window of the operative present"? storage value is subject to ever shrinking "endurance". The museum, whose primary functions are to store and preserve can only resist to this accelerated time when staying off-line, thereby suspended from immediate consumption.

- against physical tendency of matter to dissolve into disorder, culture operates by creating and maintaining literally un-natural orderly states. For Christian theology, the New Testament (the letters of apostle Paul), *katechon* is the term for delaying the return of the Anti-Christ, that is: the end of the world (later to justify the political order of the Roman empire and other institutions)

- archivological "Sperrfrist", that is: logical (symbolical) or physical (*off-line*) dis-connection from immediate access; storage: "Die Festungen *schützen Raum und gewinnen Zeit* [...]" = E. v. H., Die Festungen in der modernen Kriegsführung, in: Im Neuen Reich, vol. 1 (1871), 53; § "Agencies of cultural feedback: the infrastructure of memory (the archive)" = WASTE; Michael Thompson, Rubbish Theory. The creation and destruction of value, Oxford UP 1979

- channel of transmission as explicit *medium* central to the Shannon diagram of communication; storage function is not expressed, rather implicit in act of encoding / compression. In reverse, the museum (like the archival record) is emblematic for the exclusive storage function: "For of the three functions of a Universal Discrete Machine (storage, transfer, and processing of input data) two functions, transfer and processing, are omitted in a museum. Nothing must be changed in things that are preserved [...]" = Kittler 1997: 69

- "temporally" suspending the channel of transmission, just like the book-printed text suspends the channel of transmission by becoming a frozen medium itself. The essence of the museum is its storage function, to except cultural values from the economical circulation: a literally *ana-chronistic* medium.

- archaeology no longer snatching past cultural values from the soil for supplying museum store-rooms; nowadays industrial and rubbish-archaeology analysing the present in real-time[591]

591 See Italo Calvino´s description of xxx in: Invisible Cities, xxx

- indicative of the digital condition that the traditional material object is now expressed by a term which is already derived from computer graphics and the digital architecture of *n*-dimensional mathematical space: the "3-D object"; strategic advice for museums is counter-resistance against virtual worlds. the material object in its incalculable contingencies, physical endurance and multi-modal interactions with human sensation - Benjamin's *aura* - can not easily be maintained by conversion into digital registers

The new role of the museum (object)

- "Für prozessuale künstlerische Interventionen im Internet gibt es <...> keine Archivierungsform mehr"[592]; shift of emphasis from fixation to transmission of cultural value

- the museum becoming a katechontic institution of materialities against the ephemerality of data in Cyberspace

- between memory and erasure, cultural memory not located in separate or even secret institutions like the museum and the archive any more, but literally *online* coupled to permanent feedback in present discourse as negotiation: ckultmat-lager / *Feedback*, the sender's monitoring and adaptation of his or her own message by observation of its effects on the recipients, became a key term of systems theoretic communication theory <...>. *Negative feedback* influences the sender to correct or change the message because of observed undesired effects. It thus contributes to communicative homeostasis, the maintenance of a steady state. *Positive feedback* reinforces existing structures of the message.[593]

- museum not the terminal for parcel post from history, art and culture any more. Instead the museum becomes a flow-through and transformer station, a relay. Its task now is mobilizing, defreezing the accumulation of objects and images in its repositories, making them accessible to the public by displaying the stacks or recycling them into the exhibition area. This corresponds to the fleeting character of the past in electronic memory: Point of light on the screen flash past as expressed by Walter Benjamin when in his essay *Über den Begriff der Geschichte* he wrote that the past can onlybe recorded as an image which simply flashesthrough one´s mind at the moment ofits dicernibilitynever tobe seen again; architectural memory of museums is liquefying. Mnemosyne might have been the mother of the muses; the museum though is not concerned with memory in temporal terms any more, transforming from a final, virtually eternal storage place of cultural heritage to a contaner, a kind of interim store (analogous to the language of nuclear disposal technology)

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592 Hans Ulrich Reck, Metamorphosen der Archive / Probleme digitaler Erinnerung, in: Götz-Lothar Darsow (Hg.), Metamorphosen. Gedächtnismedien im Computerzeitalter, Stuttgart-Bad Cannstatt (frommann-holzboog) 2000, 195-237 (203)
593 Winfried Nöth, Handbook of Semiotics, Stuttgart 1990, 178

- radical transformation of the relation of the object to time and space, owing to a semiosis which turns materialites and corporealities into immaterialities and pure information. In the age of the disintegration of the terms of space and time by speed (Paul Virilio), of the advancing immaterialising of information and its being caught up by recording systems in real-time, „other places" like the museum (Michel Foucault ---) become nostralgic retro-effects.

- if culture defined by is memory capacities (Lotman / Upenskij), the growing predominance of intermediary storage contributing to a radical transformation of the economy of history

- financial capital striving for minimizing the temporal lenght of storage (which then is „dead capital"); the supply system of the Benetton company virtally programs its storage time to zero by a supply-demand-relationship aiming at real-time; eletronic random access to the stores turning memory into omnipresence of commodities

"Museums on the Digital Frontier": An *updating* of Kittler's approach

- museum in digital culture not simply computer-augmented museum space, "focusing on the multimedia dream of making things more user-friendly" (Kittler). In reverse, virtual reality allows "to enter the architecture of digital media" = Friedrich Kittler, Museums on the Digital Frontier, published in: Thomas Keenan (ed.), The End(s) of the Museum, Barcelona (Fundació Antoni Tàpies) 1996, 67-80 (77); von-Neumann architecture of computing replacing traditional museum architecture. Navigating the computer from within: Virtual reality allows for making visible hard- and software; still, an observational second-order-observation paradox (as expressed by Heinz von foerster) arises. The computer - even if it absorbs all other previous agencies of cultural memory - can not itself be displayed from within - unless in real-time emulation: "The computer medium can archive all other media but not iself" = Kittler 1996: 78

- "Computer museums <...> would have to store state diagrams [...], hardware architectures and software solutions - and store them so precisely as to preserve at least the validity of mathematical algorithms" <ibid.>. But in order to preserve the cultural memory not simply of the technics and logics of the computer but actual *computing*, this has to happen in an executable way - beyond the *stasis* of traditional archival records.

- the contemporary "museum of algorithms" is Github, "one of the largest dynamic repositories of software online, can be seen to operate as a mode of archive which in turn re-engineers the question of what an archive is. [...] Github is a place where software is stored online and from which it can often be downloaded. More expansively, it provides a sense of the archive as simultaneously a site of fine-grained analysis and of incoherence, of storage and of production. To get to Github, we need to start with Git, a 'source code management' (SCM) system designed by Linus Torvalds in 2005. 1 Git was initially based on the characteristics of a file storage system familiar to its

author as the initiator of the Linux aspect of the GNU/Linux operating system."[594]

- Kittler's 1996 lecture at Barcelona a self-fulling prophecy: challenge of archival preservation / emulation of his self-written source codes within a functional operating system / server structure; project *Museum of Algorithms* (Christiane zu Salm)

Digitally interfacing the museum from within: new options of sorting images

- *Rijksstudio* developed by the Media Lab at the Rijksmuseum Amsterdam to become one's own virtual curator[595]; and Tate Britain, initiative *Tate Collective*, funded by the xxx Foundation: In a middle gallery room, experimental space for virtual sorting of images, experimenting with other forms of hanging alternative to e. g. St. Petersburg hang; connecting to youth experience in current media culture: web photo, text and video microblogging platform like www.tumblr.com>

- complex game of finding and relating objects to each other with the possible use of 200 000 objects

- analytic and critial "pixelisation" of museum paintings like Gustav Klimt (in the work of the Georgian media artist Tea Nili) or Damien Hustinx' work (in the current exhibition Pixels of Paradise, in Paris, until March 2015)

Recirculating digital memory: the Delay Line

- like within the bi-polar oscillation between transmission and storage (conquering space or time) in cultural tradition, within the micro-cosmos of digital memory, records are either fixed in magnetic *latency* (such as ferrit core memory) or circulate in electro-algorithmic motion

- memory becoming a latency, coupled to the present in feedback loops which result in periodic up-dating

- envisioning a dynamic storage medium by wave speed, using thermic metaphors. In a closed circuit delay line, the signal as information carrier, at any time, is at a different point of space. By high-frequency modulation, though, it is possible to "freeze" such dynamic memory: "Zu einem passenden Zeitpunkt wird durch ein kurzzeitiges Hochfrequenzfeld die Welle im Kabel fixiert (gespeichert, eingefroren)." Horst Völz, Versuch einer systematischen

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594 Matthew Fuller, Andrew Goffey, Adrian Mackenzie, Richard Mills, and Stuart Sharples, Big Diff, Granularity, Incoherence, and Production in the Github Software Repository, in: Memory in Motion. Archives, Technology, and the Social, ed. by Ina Blom, Trond Lundemo, and Eivind Røssaak, Amsterdam (AUP) 2017, 87-102 (87)
595 https://www.rijksmuseum.nl/en/rijksstudio

und perspektivischen Analyse der Speicherung von Informationen, in: Die Technik 20 (1965) 10, 650-659 (659)

- dynamic data manipulation known from early dynamic computer "memories", such as the Acoustic (mercury-based, and other) Delay Line for re-circulating binary pulse trains, functioning as a variable, scalable temporal interval replacing the cultural idealism of eternal memory. But in a close reading, a tight coupling of temperature and memory arises: mercury delay lines are highly sensitive to temperature variation, thereby limiting or even distoting the clocked pulse trains in the intermediary memory channel. "The variation in the delay through mercury depends only on temperature."[596] What happens in storage here, is true for transmission of signals as well: In echo-location by the sonar (different from RADAR based on electro-magnetic waves), which is based on measuring the Delta-*t* passing between sending and receiving back the ultra-sonic (thus vibrational, mechanical) signal, time-criticality becomes temperature-critical, since the speed of an acoustic signal considerably varies with air temperature

On the term "equirimordiality"

- equiprimordiality as time being and time givenness of technical media; Michael Inwood, A Heidegger Dictionary, Oxford / Malden, Mass. 1999, 31: Heideggerian "gleichursprünglich" = "equiprimordial", "equally original"

- "*Cronopete is a Linux clone of Time Machine, the backup utility for Mac from Apple.* It aims to mimic it as closely as possible. The name comes from anacronopete ("who flies through time"), which is a time machine featured in the novel from Enrique Gaspar y Rimbaud, and published in 1887 (eight years before than H. G. Wells'Time Machine)" = http://www.rastersoft.com/programas/cronopete.html

Experiencing media tempor(e)alities

- abondoning the transcendet notion of "time": for case "historical time", replace by (Boltzmann-) *entropy*; for case of temporal cuts: *time-criticality*

- technical *Eigenzeit* (the temporal logic inherent to its technologies) shapes the collective perception of time in media-specific ways; time itself looses its transcendent character and gets grounded in operativities. "Zeit ist damit auch die Herausforderung einer Medienwissenschaft" = Stefan Rieger, Kybernetische Anthropologie. Eine Geschichte der Virtualität, Frankfurt/M. (Suhrkamp) 2003, 143. Apart from its "social media" content, the message of the dominant communication platform of today, the World Wide Web, once analysed on its operative level, is its temporal processualities and eventalities

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596 T. Kite Sharpless, Mercury delay lines as a memory unit, in: Proceedings of a Symposium on Large-Scale Calculating Maschinery, Cambridge, Mass. (Harvard University Press) 1948, 103-109 (105)

- essence of technological media: their operative, processual, that is: temporalized mode of existence; only when being in operation a medium is truly in the medium state, otherwise the apparatus a piece of furniture; David Morley, Television: Not so much a Visual Medium, more a Visible Object, in: Charles Jenks (Hg.), Visual Culture, London / New York (Routledge) 170-189

- tele-communication extends to temporal de-distancing (Heidegger), compressing the temporal gap between past / the present; from spatial to temporal *proxemics*; "Time capsules make the timeline shrink. [...] Time machines [...] have the capacity to make the timeline implode altogether by teletransporting past things, no matter how far off temporally, to 'recency'", thereby their "pastness" is destroyed: René Munnik, Technology and the End of History. From Time Capsules to Time Machines, in: Liisa Janssen (ed.), The Art of Ethics in the Information Society, Amsterdam (Amsterdam UP) 2016, 106-109 (109); see René Munnik, Tijdmachines. Over de technische onderwerping van vergankelijkheid en duur, Zoetermeer (Klement) 2013; MED-PRESENCE

Chrono-technical irritations

- media time processes "within" concrete technologies (from analog to digital); irritative (even traumatic) impact of media temporalites on the human sense of time and finally results in most fundamental questioning of how media technologies are situated within of apart from traditional historical time

- traditional model of cultural history is challenged by the chronopoetic qualities of technological artefacts

- Jerrold Levinson / Philip Alperson, What Is a Temporal Art?, in: Midwest Studies in Philosophy vol. 16 (1991), 439-450; reprint: Jerrold Levinson, Musical Concerns: Essays in Philosophy of Music, Oxford 2015

- addressing media culture under the focused perspective of its technological tempor(e)alities: a close analysis of time-critical moments within media technologies, followed by descriptions of how media temporalites affect and irritate the traditional human sense of time, and finally questioning the traditional position of media time within cultural history; escalations of so-called time-based media analyzed in terms of time-critical processes, that is: procedures where the temporal moment is decisive for the overall success of the operation at all; requires most precise technical description on the one hand, and its media-epistemological explication on the other, in order to derive sparks of knowledge enriching the traditional philosophical discussions about the nature of time. The close microtechnical reading of time-critical processes then leads to discussing the phenomenological effects this has on human time perception. Far from remaining a transcendental signified, time itself thereby turns out to be radically pluralized by technological tempor(e)alities which generate a plethora of techno-mathematical terms enriching the vocabulary of temporal semantics - from delay time up to the autocorrelation function; delicate microcosm of technical time figures deserves epistemological reasoning, beyond the functional interest of engineers